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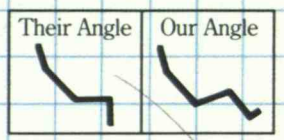

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William J. Hecht

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John I. Mattill

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FIRST LINE

An Unseen Asset

Business manager Peter Gellatly with retiring Advisory Board Chairman Claude Brenner

"A principal goal of *Technology Review* is to focus on policy aspects of technology. The magazine's task is to illuminate the option spaces—the range of possible approaches to problems and their costs and benefits—social, political, and cultural as well as economic."

That description of *Technology Review*'s role is volunteered not by its editors but by one of their advisers, Professor Emeritus David J. Rose of M.I.T. Rose is one of 15 members of an Advisory Board that serves us with expert counsel—an asset unseen but by no means unfelt by *Technology Review* readers.

The occasion for this modest tribute to our Advisory Board is the retirement of Claude W. Brenner as its chairman and the arrival in his place of Edward T. Thompson. Brenner (M.I.T.'47—aeronautical engineering) is a systems analyst and manager of technology who has been a wise and articulate adviser to the magazine for nearly a decade. Thompson, who studied chemical engineering at M.I.T. before entering the magazine world with McGraw-Hill's *Chemical Engineering*, recently retired as editor-in-chief of *Reader's Digest*.

Presiding chairman Edward T. Thompson

Other members of the Advisory Board include O. Reid Ashe, president of Viewdata Corp. of America, a subsidiary of Knight-Ridder newspapers; Dr. William Bennett, president of *Harvard* Magazine, Inc.; Robert C. Cowen, science editor of the *Christian Science Monitor*; Edwin Diamond, professor of journalism at New York University; David E. Gushee, chief of the Environmental Policy Division of the Congressional Research Service; J. Herbert Hollomon, director of the Center for Technology and Policy at Boston University; Fred Jerome, director of the Media Resource Service of the Scientists' Institute for Public Information; Victor K. McElheny, director of the Vannevar Bush Fellowships at M.I.T.; Louis Menand III, senior lecturer in political science at M.I.T.; Professor Emma Rothschild of the M.I.T. Program in Science, Technology, and Society; Professor Lester Thurow of the Sloan School of Management; and Frank Urbanowski, director of the M.I.T. Press.

The loyalty and interest of these advisers represent a resource beyond price. It is a pleasure to pay this all-too-modest tribute, and to record in public the editors' collective thanks.—*John Mattill*

LETTERS

Windfall for Windmills?

In "Harvesting the Wind" (*November/December, page 56*), Robert Kahn implies that tax breaks for wind energy cost the U.S. Treasury and taxpayers only about 25 cents per dollar invested. Yet promotional literature on wind-energy tax partnerships admits that 90 percent of the investment will be picked up by Uncle Sam—at a time when the federal debt is increasing at about $333,000 a minute.

These advertisements urge investors to put up $6,000 and get $52,750 in tax breaks. Most windmills are constructed in December to get the advantage of the tax credit, even though little or no energy has been produced that year. We need energy independence and clean energy—but there are better ways to reach those goals.

One major wind producer informed me that the industry could survive if the tax credits existed only through the end of 1985. Extending the credits would give efficient, well-engineered companies a windfall and subsidize many less efficient operators. We can find new forms of energy without encouraging blatant fraud, waste, and abuse.

Fortney H. (Pete) Stark
Washington, D.C.

Congressman Stark represents the 9th District of California.

PHOTOS: FRANK REVI

The author responds:
Spotlighting the wind industry is an odd way to address the emergency of the federal deficit. When 1984-85 federal "tax expenditures" for wind and other renewable-energy technologies are contrasted with those enjoyed by oil, gas, synfuels, and coal, Congressman Stark's rhetoric seems disproportionate indeed.

In a study released in November, the Congressional Joint Committee on Taxation tallied $8.65 billion in tax subsidies for individuals and corporations developing fossil-based resources. Yet the total for all renewables, including the residential solar tax credit, is only $1.23 billion. Other federal expenditures such as the extravagant support for nuclear power have been even more lopsided.

In the best of worlds, an "unfettered" marketplace would insure equitable competition among energy technologies. But for the flawed present, federal policy cultivates a promising renewable resource—the wind—by encouraging affluent people who can afford the risks to produce it.

Nearly everyone I interviewed criticized the few unscrupulous developers who operate in the windfarm market. After I filed my story, the American Wind Energy Association established a self-policing ethics panel—hardly an action one expects from an industry encouraging "blatant fraud, waste, and abuse." One hopes Washington will avoid throwing the baby out with the bathwater.

Chancy Oil Supplies

All efforts to tap oil resources, including those Henry Petroski describes in "Offshore Engineering: Oil from Troubled Waters" (*July, page 52*), follow a common pattern. Output from highly productive wells increases, after which supplies inexorably decline as wells begin to run dry and large fields can no longer be found.

In the United States, this inexorable decline started in 1970—the "large" fields found here lately have been pathetically inadequate. For example, discoveries in Prudhoe Bay in Alaska would supply no more than 14 months of domestic demand. The 1-billion-barrel field recently found off California would supply U.S. needs for only 60 days, and the 100-million-barrel field mentioned by Patrick Lawrence in "Milking Offshore Oil and Politics" (*August/September, page 38*) would last less than one week.

Yet producing the oil from all these fields will take decades. By the year 2005, finding and refining a barrel of oil in the United States will cost more than the oil itself. All attempts to increase production now will simply worsen our problem later.

Success in conserving energy and finding alternative sources, coupled with a world recession, have produced a modest oil glut and soft oil prices. The U.S. should take advantage of this period to reduce its ad-

Continued on page 40

ROBERT C. COWEN

Secrets of the Space Shuttle

HERE'S a news item to pique the interest of Pentagon censors. When Navy Captain Robert L. Crippen and Air Force Lieutenant Colonel Guy S. Gardner make the first shuttle flight launched from Vandenberg Air Force Base in California early next year, they will carry a "secret" payload. On board will be the Teal Ruby aircraft-detection satellite. According to the Associated Press, this satellite is equipped with infrared instruments that can detect objects in the atmosphere such as cruise missiles and airplanes, as well as ships at sea.

If news media repeat that fact when the mission takes off, will the secretary of defense accuse them of giving "aid and comfort to the enemy," as Caspar W. Weinberger did in December? That was when the *Washington Post* reported what many other news organizations already knew: that the mission of the first military shuttle flight, which took place in January, was to place a "Sigint" (signal-intercept) satellite in orbit to eavesdrop on electronic communications.

The fuss over the issue of military secrecy versus the public's right to know obscured an important fact. Both the military and the news media had generally tried to accommodate each other's needs concerning the flight. Several news organizations, including the major TV networks and the Associated Press, withheld stories on the mission payload at the request of the Department of Defense (DOD), even though the articles were based on public information. (AP later released its story after the *Post* article appeared.) And the ground rules worked out by DOD and the National Aeronautics and Space Administration (NASA) for press coverage of all military shuttle flights seem somewhat liberal for a supposedly secret operation.

According to these rules, NASA will provide no official information on cargo, no press kits, no public access to shuttle-ground communications, and no news conferences with crews before or after missions. The space agency will give brief status reports on a mission during countdown, beginning an hour before a three-hour launch window opens. To deny Soviet trackers the information they need to preset their ground and satellite equipment, NASA will indicate only that launch will occur some time during that window. NASA will issue statements on mission progress every 8 hours and give notice of landing time only 16 hours in advance.

Both the Defense Department and the press acted responsibly in the fuss over space-shuttle censorship.

As Brigadier-General Richard Abel, chief Pentagon public-information officer, explained to the press, "Our intention is to make the maximum information available to you consistent with national security. We want to deny our adversaries any information that might reveal the identity or mission of DOD payloads."

He should have left it at that. But he added that "speculation" in the media as to the nature of the payloads could trigger a DOD investigation to see if national security regulations had been violated. His deputy, Colonel Michael P. McCraney, later softened the comment by explaining that such speculation wouldn't automatically lead to investigations. However, some elements of the press plainly took this as a challenge. Hence the *Post* article.

The DOD shuttle regulations are hardly a cloak-and-dagger cover. However, the 46 U.S. manned space flights that preceded the first military mission had been completely open to press coverage. Moreover, NASA's original mandate was to make information on its operations widely available. Thus, the press had lost sight of the fact that about 20 percent of the 70 shuttle missions to be launched in the next five years will be military. The expectable secrecy came as a shock.

Commercial Imperatives

This military secrecy needs to be seen in proper perspective. Manned flights before the shuttle began operating were national achievements in their own right. The spacecraft involved were specialized vehicles specifically designed to make those achievements possible. Hence the missions were public. The shuttle program is different. The spacecraft constitute a general-purpose earth-to-low-orbit transport system—trucks whose services are offered for hire. Shuttle "missions" are not national adventures but commercial operations.

DOD is not an overlord but a customer, like the satellite-communications companies and other businesses that hire shuttle services. No one turned a hair when commercial secrecy was imposed on the electrophoresis experiments of McDonnell-Douglas and Johnson & Johnson, aimed at making pharmaceuticals in orbit. DOD also would like its business kept secret. And since it pays for entire shuttle flights, you could say that it has a right, quite apart from national security considerations, to ask for a news blackout.

Moreover, DOD is a somewhat reluctant customer. NASA officials have repeatedly stated that without DOD business, their plans to eliminate operating losses on the shuttle would be thwarted. But DOD is so skeptical of the shuttle's ability to keep to the launch schedule that it has obtained authority to maintain its own fleet of unmanned launch vehicles.

In short, there is no threat that the military will corrupt the civilian U.S. space program. The press should recognize this and stop raising alarms over prudent secrecy measures. Likewise, Pentagon officials should be mature enough to realize that the American press, which has traditionally acted responsibly when the nation's welfare is truly involved, is not giving aid and comfort to real enemies. □

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*

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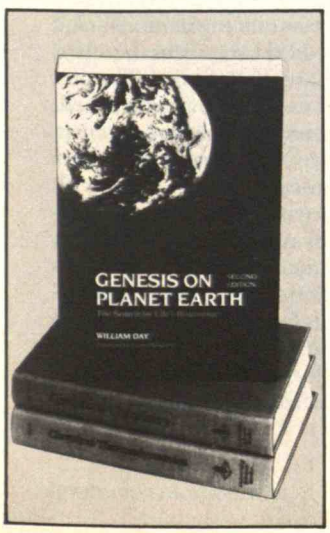

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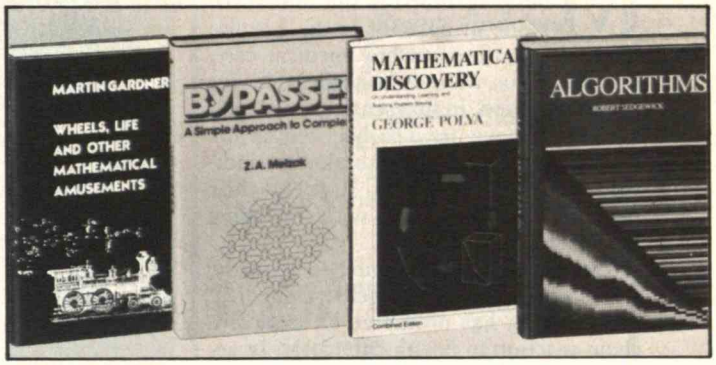

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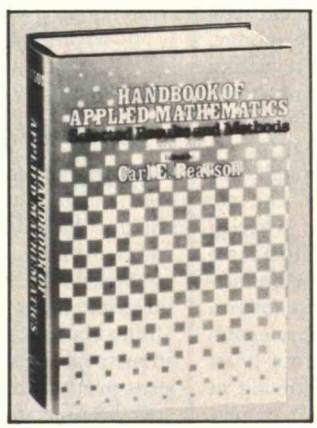

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Technology Review 2-3/85

LESTER C. THUROW

An Antidote for Soaring Health-Care Costs

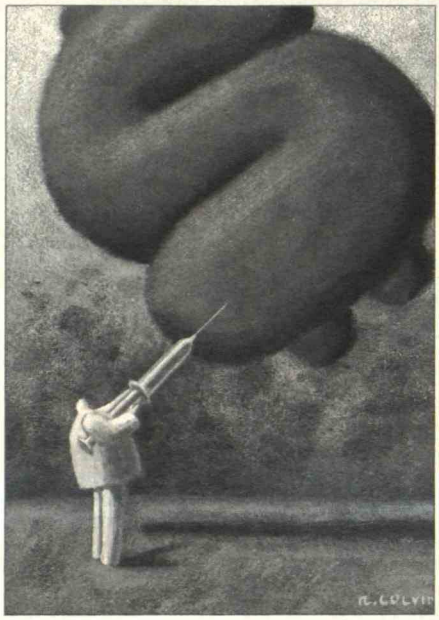
Most Americans are simultaneously egalitarians and capitalists. None of us want to die because we cannnot afford to buy medical care, and few of us want to see others die for the same reason. In that sense, we are egalitarians. Yet we are also believers in the free-market system. We think that individuals should be allowed to spend their money on whatever they wish, including health care.

This set of beliefs, combined with the advent of ever-more-expensive medical technologies, has prompted an explosive chain reaction in health-care costs. In accordance with free-market principles, the wealthy are allowed to buy a particular medical treatment privately regardless of its cost or effectiveness. But moderate-income individuals who cannot afford the treatment also demand it. Being egalitarians, Americans do not have the political ability to say "no." We find ways to provide the treatment through private or public health insurance.

Such a situation arose in Massachusetts in the summer of 1983. To save money, state regulatory agencies were preventing local hospitals from performing heart transplants. Some citizens could afford to fly to California to receive a transplant; others were unable to go even though they needed a transplant just as much. The media and the public essentially wheeled those needing treatment up to the State House steps and dared the public authorities to let them die for want of treatment. Not surprisingly, the authorities relented. They agreed to pay for California heart transplants and soon began allowing at least one Massachusetts hospital to perform the procedure.

Being egalitarians, we feel we have to provide the treatment to everyone or deny it to everyone; being capitalists, we cannot deny it to those who can afford it. But it is becomingly increasingly obvious that we cannot afford to give all treatments to everyone, either. As medical costs rise, it becomes less possible to live with our inconsistent ethical beliefs. At some point, these inconsistencies must be sorted out.

LESTER C. THUROW IS GORDON Y BILLIARD PROFESSOR OF MANAGEMENT AND ECONOMICS AT THE SLOAN SCHOOL OF MANAGEMENT AT M.I.T.



Doctors must develop guidelines on when too much medicine is bad medicine. If they don't the government will.

The United States is reaching this point sooner rather than later because of the slow productivity growth in the economy and the need to remain competitive internationally. If U.S. productivity had consistently grown at pre-1965 rates, today's health-care spending would absorb only 7 to 8 percent of the gross national product instead of 11 percent. Hence, there would be much less pressure to control health-care costs.

International competition generates a related set of pressures. In terms of wages, American autoworkers make only slightly more per hour ($11.80) than Japanese autoworkers ($10.27). However, when fringe benefits are included, the differential is enormous—$13.50 in Japan versus almost $22 in the United States. Private health insurance accounts for $2.74 per hour of those fringe benefits at the Chrysler Corp., to take one example. If U.S. companies cannot control their health-care costs, they cannot compete in world markets.

Furthermore, the United States spends a lower percentage of its GNP on civilian R&D than all its major competitors. And the educational attainments of the American labor force do not measure up to world-class standards. These problems must be cured to restore productivity, and all the cures require funds. As a result, money that could otherwise be spent on health care will have to be diverted to solve these problems. The United States cannot maintain the present rate of growth in health-care spending while restoring productivity growth and international competitiveness.

A System without Constraints

Insurance has been our traditional solution for individuals who cannot afford health care. But it is not the answer here. Insurance is an appropriate remedy when there is a small probability of a disaster that will incur large fixed losses. For instance, only a few of us will be unfortunate enough to have our home burn down. However, in the case of health care, almost all of us face the probability of incurring large expenditures before death. Furthermore, we are talking about losses that are not fixed, as in the case of the burnt house, but elastic, depending on how we plan to treat our ailments. Since we are dealing with our own health and life, each of us has a major incentive to take the "don't spare the expenses" route.

Under the health-insurance system, which pays for future treatments instead of refunding previous losses, the individual price of health care appears to be set below costs. Each of us makes a lump-sum payment—our insurance premium—and when we use medical care, insurance pays all or a large part of the bills. This encourages each of us to consume more medical care. On the margin the care is cheap, but when we all use more services we raise next year's lump-sum payments.

Under these circumstances, our insurance system ends up as one without constraints. Insurance companies have an interest in promoting health-care expenditures, since higher premiums lead to higher corporate incomes. Doctors practicing in a fee-for-service system have a personal interest in prescribing services

ILLUSTRATION: ROB COLVIN

since they raise their own incomes by doing so without directly raising costs for their patients. The result, not surprisingly, is a system of exploding expenditures.

The health-care problem is not a federal or state budget problem. It is a social problem. The costs are the same regardless of whether the money is spent through the federal budget or private insurance. Somehow we must learn to say "no."

U.S. physicians have traditionally used treatments until they yielded no additional payoffs. But new and increasingly expensive medical technologies can now prolong life indefinitely or slightly improve the accuracy of diagnoses. In the case of a terminally ill patient, for instance, such technologies enable the lungs to pump or the heart to beat long after the rest of the body has given out. These new technologies require a shift in standard medical practice. Instead of ending treatments when all benefits cease, treatments must be stopped when marginal benefits are deemed no greater than or equal to the cost. But who should decide when it is simply too expensive or inappropriate to keep a terminally ill patient alive? How do we as a society decide that we cannot afford to offer a medical treatment that may benefit someone?

One possibility would be to place greater reliance on market mechanisms. But by doing so we would basically decide that our capitalistic ethics will dominate our egalitarian values. The free-market system is a way of saying "no," but doing so in a very inegalitarian way. Since the richest 20 percent of all U.S. households has 11 times as much income as the poorest 20 percent, any efficient market mechanism will end up giving 11 times as much medical care to the top 20 percent as it gives to the bottom 20 percent.

Individuals are not true believers in the free-market system unless they can honestly say they would be willing to see some patients die if they could not afford treatment provided to wealthier patients. If we can't really accept that premise, then we simply won't let the market work.

A New Social Ethic

Another answer is for the government—as the largest insurer of public health care—to decide which services third-party payers can pay for. Such regulations would also prohibit Americans from buying what is not covered by the private or public insurance systems. This is essentially how the British have kept health-care spending at levels half that of ours. It is extremely rare for patients over the age of 55 in Great Britain to receive kidney dialysis. It is also rare for individuals over the age of 70 to be admitted to intensive-care units. In the United States, dialysis is provided for some patients over 90, and age is virtually never a barrier to admission to intensive care. But while the British restrictions do keep expenditures down, they set seemingly arbitrary limits. And they do not take into account the subtle differences among individuals' medical problems.

It would be far better for U.S. doctors to formulate a professional ethic that helps them decide when medical procedures are inappropriate—not simply because they do not benefit the patient, but also because the marginal benefits do not justify the costs. To do this, the medical establishment must develop better information on the cost-effectiveness of new medical techniques, and then act on that information. For instance, at what point do other ailments or simply old age vitiate the use of artificial kidneys?

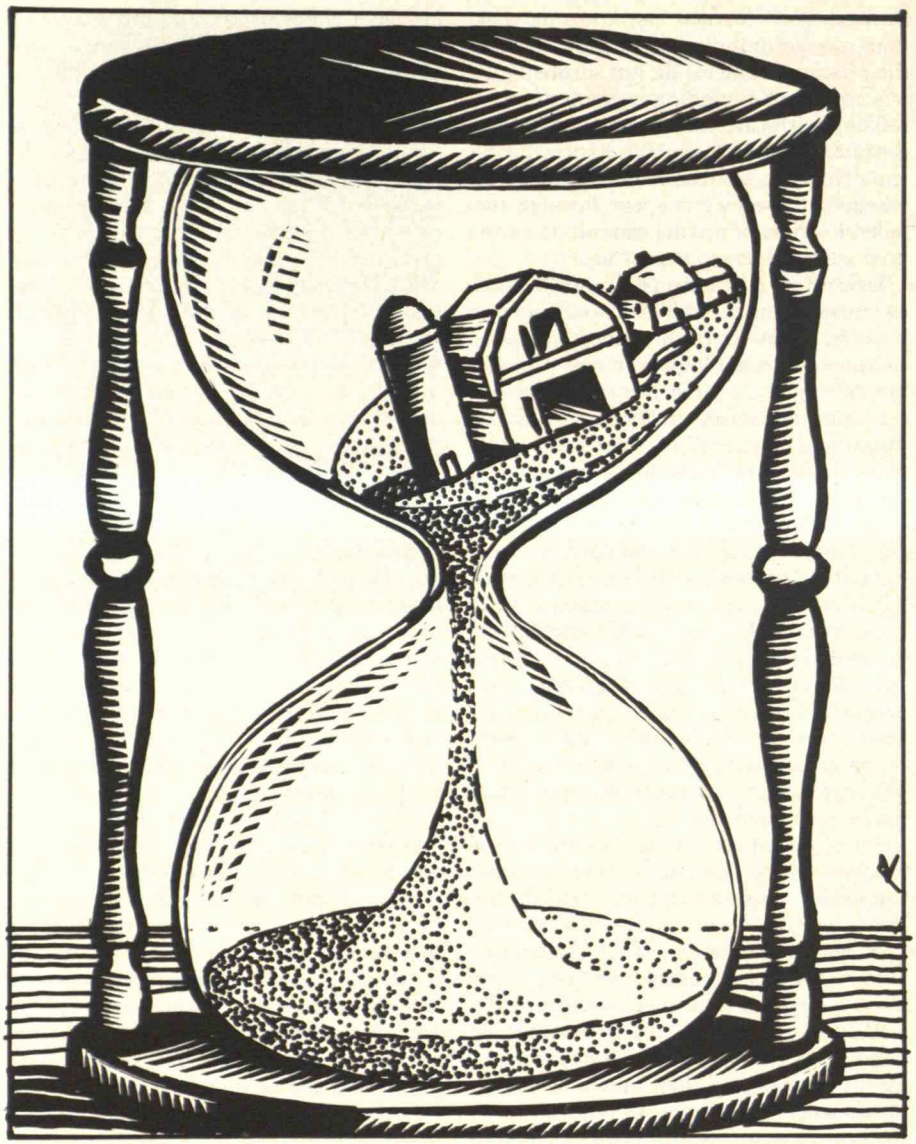
The medical profession already maintains professional norms concerning what constitutes bad medical practice. These norms should be expanded to include cases in which high costs are not justified by minor expected benefits. For example, if a doctor knows that an illness is terminal and that care will prolong death for only a couple days or hours, resuscitating the patient when his or her heart stops beating could be considered bad medical practice. If such guidelines are developed and then legally defended against malpractice suits, it just may be possible to build up a system of doctor-imposed cost controls that would be much more flexible than controls imposed by third-party payers.

If the medical profession fails to do this, sooner or later the United States will move to a system of government-imposed controls. Like it or not, Americans are going to have to develop a social consensus on the trade-off between the costs of medical services and the life-extending benefits they bring. □

A version of this article appeared in the New England Journal of Medicine.

BY JUDITH RANDAL

Time to Halt Soil Erosion



In western Tennessee, up to 100 tons of topsoil are lost per acre each year that there is heavy rain. Even in "good" years, soil in that part of Tennessee disappears at the rate of 15 to 25 tons per acre. Indeed, 10 million tons of precious topsoil are washed or blown away from the nation's 413 million acres of cropland each day, largely from the fertile Middle West, Southeast, and Great Plains states.

New technology now makes it possible to more accurately measure soil losses and pinpoint the most critical areas. But farmers and policymakers alike seem wedded to wasteful ways. If our farmland continues to erode at its present pace, food prices will inevitably rise and a time may come when we will be unable to feed ourselves, let alone provide for the hungry overseas. Even though our nation has invested huge sums in safeguarding our agricultural productivity, we have failed to pay enough attention to controlling soil erosion.

"Despite the existence of the Soil Conservation Service (SCS), conservation has been the poor relation of agricultural policy," says Kenneth Cook, principal author of *What Do We Have to Lose?*, a recent report by the American Farmland Trust. Cook notes that SCS devotes only 30 percent of its staff time to actual erosion-control measures; the rest is spent on related responsibilities such as soil mapping, database development, irrigation, and flood control. As a matter of fact, more and more of the agency's resources have been earmarked for these other purposes. Whereas 85 percent of the SCS budget was invested directly in controlling soil erosion in the 1950s, only 60 percent of its money is now spent on these measures.

Even though the SCS will be 50 years old on April 27, its semicentennial celebration could turn into a wake. As part of the effort to reduce the national deficit, the Office of Management and Budget (OMB) has proposed slashing the SCS budget by almost two-thirds in the coming fiscal year. The reduced budget would be used to meet the agency's standing commitments and then to phase the agency out of existence.

Why are we so intent on destroying our agricultural heartland? The attitude of most Americans is partly to blame. We want desperately to believe that our nation's resources are infinite. Because food has always been cheap in this country, and we have usually produced agricultural surpluses, Americans have difficulty believing that we could confront a shortage of productive land. This attitude persists despite the fact that housing developments, shopping centers, and other projects are gobbling up about 220 acres of farmland a day.

Furthermore, many Americans are confident that some technological "breakthrough" will come along to compensate should farmland become exhausted. The truth is that no amount of fertilizer and pesticides will rejuvenate severely denuded land. And these agricultural chemicals are derived from petroleum, so they are nonrenewable—not to mention expensive and in some cases environmentally hazardous.

Long-established farming patterns present another problem. Two-thirds of the land most vulnerable to erosion is planted to row crops such as cotton, soybeans, corn, and sorghum, which produce little ground cover and have shallow roots. These traits bode ill for soil integrity because they put millions of acres of cultivated earth at the mercy of wind, sun, and storm. Land planted with these crops loses more than 5 tons per acre of topsoil a year.

JUDITH RANDAL is the Washington-based science reporter for the New York Daily News.

ILLUSTRATION: ANTHONY RUSSO

Working at Cross-Purposes

The way government agricultural agencies establish policy and administer funds also affects soil erosion. Locally based SCS staff members are expert at visiting farms and advising farmers on what kind of erosion-control measures would be most helpful. But these specialists often cannot help farmers act on this advice, as subsidies for farm improvements are meted out by the Agricultural Stabilization and Conservation Service (ASCS), a different agency of the Agriculture Department.

It has been that way since the Great Depression, when the SCS was set up to provide technical assistance to local soil-conservation districts and the ASCS was created to funnel income to impoverished farmers. Few controls were established on how ASCS monies were to be used. Thanks to the political power that this freedom spawned, the agency continues to distribute its limited largesse with relatively few strings attached. As a result, the SCS and the ASCS end up working at cross-purposes much of the time.

Thus, despite the word "conservation" in the agency's name, the state and county committees that decide how to allocate ASCS funds often give conservation projects low priority. Nor do these committees insist that the conservation projects they do approve employ the most cost-effective techniques. As one Agriculture Department official explained to Cook, "The committees have a certain amount of money to spend and they try to spread it around as best they can. If a farmer comes in who meets the eligibility requirements, he'll stand a good chance of getting the money. It doesn't matter if his land is eroding at the rate of 1 ton or 20 tons a year because the selection criteria aren't tied to erosion."

Meanwhile, a shaky farm economy has plunged many farmers deeply into debt and made it all but impossible for them to pay for improvements that won't yield quick cash returns. Willing and even eager as some farmers are to be better stewards of the land, the limited resources of the ASCS preclude that possibility.

Commodity price-support programs are a further disincentive to conservation practices. These programs guarantee farmers an income if there is a crop and, should the crop fail, qualify them for disaster or crop-insurance payments to help offset the loss. Hence, farmers often find it more profitable to plant crops on as much terrain as possible—even on marginal acreage. So though the government does sometimes pay farmers to take surplus land out of production, they have a greater incentive to plant crops. To make matters worse, the price-support programs have been heavily geared to increasing the production of row crops for export. As a result, more land is exposed to erosion.

However, phasing out the SCS, as proposed by the OMB, is not the answer. Obviously, neither the SCS nor the ASCS is perfect. What we need is better coordination between the two agencies, not complete elimination of technical efforts to control erosion. While it may be argued that an SCS presence in every one of the nation's 3,000 counties is unnecessary, such offices do increase political support for the cause. Some shift in direction for the SCS is obviously needed, but simply terminating the agency and its functions would be like throwing the baby out with the bathwater.

A Chance for Reform

Despite all these obstacles, there is hope for change. Opportunity will knock when the present farm bill expires on September 30: replacing it will provide a chance to introduce some reforms. For instance, the new law could disqualify farmers for technical or financial aid unless they show sustained efforts to curb soil erosion. Fines or other penalties could be levied against those who grow crops on erosion-prone land without taking steps to protect productivity.

However, farmers are a fiercely independent lot and such sanctions could cause resentment and backfire. Thus, a more voluntary approach might pay bigger dividends. For instance, local conservation committees could negotiate contracts to compensate farmers who set aside deteriorating but salvageable land for up to 7 to 10 years.

This idea is potentially attractive to farmers because it would leave them free to earn money from the acreage. They could use it for some purpose such as hay, pasture, or timber that, if properly managed, would prevent erosion and help rebuild the soil. The compensation under such an arrangement would be lower than that offered by programs that pay farmers

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SCIENCE/SCOPE

Two communications satellites rescued by NASA's space shuttle in November are being refurbished to be launched again. The spacecraft were brought back to Earth after shooting into wayward orbits nine months earlier when their rocket motors misfired. Spacecraft controllers at Hughes Aircraft Company spent months taming the satellites and bringing them into orbits low enough that they could be reached by the shuttle. Their efforts were the most sophisticated series of orbital maneuvers ever attempted. In addition, Hughes and NASA engineers worked tirelessly to develop hardware that permitted the actual recovery. The satellites emerged in good condition. Most of the electronics were never turned on, but certain items—batteries, thermal blankets, and thrusters—are being replaced.

An Air Force radar is helping customs officials detect drug smugglers along the southern border of the U.S. The radar, a current production version of the AN/APG-63 installed in the F-15 Eagle fighter, is carried by a Navy P-3A Orion long-range patrol aircraft. The APG-63 radar was adapted easily to the special requirements of the U.S. customs service by making small changes to its versatile software system. These special requirements include detecting and tracking slow, small low-flying aircraft of the type used to smuggle contraband into the country. The radar detects both airborne and surface moving targets and provides vectoring information to enable the U.S. Coast Guard or other government agencies to intercept suspects. The Customs Service plans to operate a fleet of six Orions equipped with the Hughes radar.

A computer center for improving productivity is one special feature of a new 500,000-square-foot facility at Hughes for manufacturing sophisticated electro-optical devices for the military. The computer-aided manufacturing center serves several purposes. It allows engineers to design tools and fixtures with the aid of computer graphics. It also lets them write specifications, planning procedures, and test procedures—and be checked automatically by computer. By gathering data from automatic test equipment, the center gives engineers insight into every facet of manufacturing, including production rates and quality.

A new 5-volt-only, 256-bit nonvolatile random access memory combines the data retention capabilities of an EEPROM with the convenience of a CMOS RAM. The Hughes circuit, designated H13500, is designed for such applications as reconfigurable systems and fault protection without battery back-up. It is organized as 64x4 bits. Both the read and write operations are performed as in a standard CMOS RAM. A single store operation transfers all data in the RAM cells in parallel to the background EEPROM array. The recall operation restores data in parallel to foreground RAM cells.

A broad spectrum of technologies, many of which grew up within the past five years, are represented in the products of Hughes Industrial Electronics Group. Six divisions and two subsidiaries, each operated like a small high-tech company but backed by resources of its multibillion-dollar parent, offer career benefits to qualified engineers and scientists. Advancing technologies such as microwave and millimeter-wave communications, silicon and GaAs solid-state circuitry, fiber optics, and image processing equipment are pursued in facilities located in many of Southern California's most desirable coastal communities. Send your resume to B.E. Price, Hughes Industrial Electronics Group, Dept. S2, P.O. Box 2999, Torrance, CA 90509. Equal opportunity employer. U.S. citizenship required.

For more information write to: P.O. Box 11205, Dept. 67-9, Marina del Rey, CA 90295

HUGHES
AIRCRAFT COMPANY

BY CHRISTOPHER T. HILL

Rethinking Our Approach to Science and Technology Policy

TODAY as never before, our nation is calling on science and technology to lead the charge in response to foreign competition. This challenge has motivated both Congress and the administration to reexamine the adequacy of our federal research and development efforts and the mechanisms used to support R&D. Federal policymakers are also rethinking the relationship between university research and graduate education.

The Reagan administration likes to say that it has followed a radically different tack from preceding administrations on these issues. Yet current science policy is based on the same premises that have guided it since World War II. These tenets may have sustained us in the past, but there is reason to ask whether they are adequate for the international contest we face today. Some fundamental changes in our national science and technology policy should be considered as we work to remain a technological superpower.

CHRISTOPHER T. HILL is a senior specialist in science and technology policy at the Congressional Research Service of the Library of Congress. The opinions expressed here are his and not those of CRS or any congressional unit.

To begin with, many people talk about R&D as if this term referred to activities that are similiar no matter what field of science is involved or where the work is done. Not so. Drug development by the pharmaceutical industry is not the same as university research into antisocial behavior among monkeys, nor is it the same as research in high-energy physics at government laboratories. Each of these efforts entails different social processes, and each field defines truth differently. Some researchers sit, ponder and scribble, some observe natural phenomena, and still others carry out highly stylized and controlled experiments.

Physicists have had enormous influence on science and technology policy during the last few decades. While this influence reflects the many important contributions of physicists, especially to military technology, it has tended to promote their view of what constitutes good research as the touchstone of quality in other fields. Physicists value quantification, elegant experimentation, and uniqueness and simplicity of explanation. They often pursue experimental confirmation of theories rather than falsification of hypotheses.

Needless to say, anthropology, psychology, ecology, and chemical engineering, among other fields, don't work this way. Yet influential physical scientists have challenged federal funding for social science on the grounds that the existence of competing models in these fields is a measure of their inadequacy, rather than an indicator of the great complexity of the phenomena with which they grapple. Some social scientists have attempted to emulate the physicists' model of science, and the result has been what many social scientists consider an overemphasis on quantitative and reductionist approaches. Similarly, fields such as ecology, which emphasize holistic rather than reductionist approaches, and chemical engineering, which must rely on empirical models of complex processes, struggle for recognition as suitable subjects for federal R&D support.

Most observers of science and technology policy use three standard categories of R&D—basic research, applied research, and development—in deciding which activities government should support. However, the more I try to use these categories, the less helpful they seem to be. For instance, basic research is usually

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ILLUSTRATION: KEN CONDON

Software that

Summary:

GTE computer scientists are producing software to help develop a variety of things, from telephone networks to integrated circuits—software that writes other software; software that designs microcircuits; even software that has its own intelligence.

Modern telephone systems are essentially special-purpose computers. Their software represents more than half of their cost, and this figure is rising.

GTE research is aiming to improve both productivity in software design and its quality. Two different compiling systems are helping us (compilers aren't new, of course, but these are special).

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Our General-Purpose Compiling System (GPCS) does not work with only one language and computer as ordinary compilers do. GPCS was designed to be independent of host and target machine, and support Pascal, Ada and CHILL. It was also designed to permit automatic language translation between these supported languages.

Our researchers have completed work on GPCS, and it is now in our software development facilities. There, it will write software for new switching systems at increased productivity levels.

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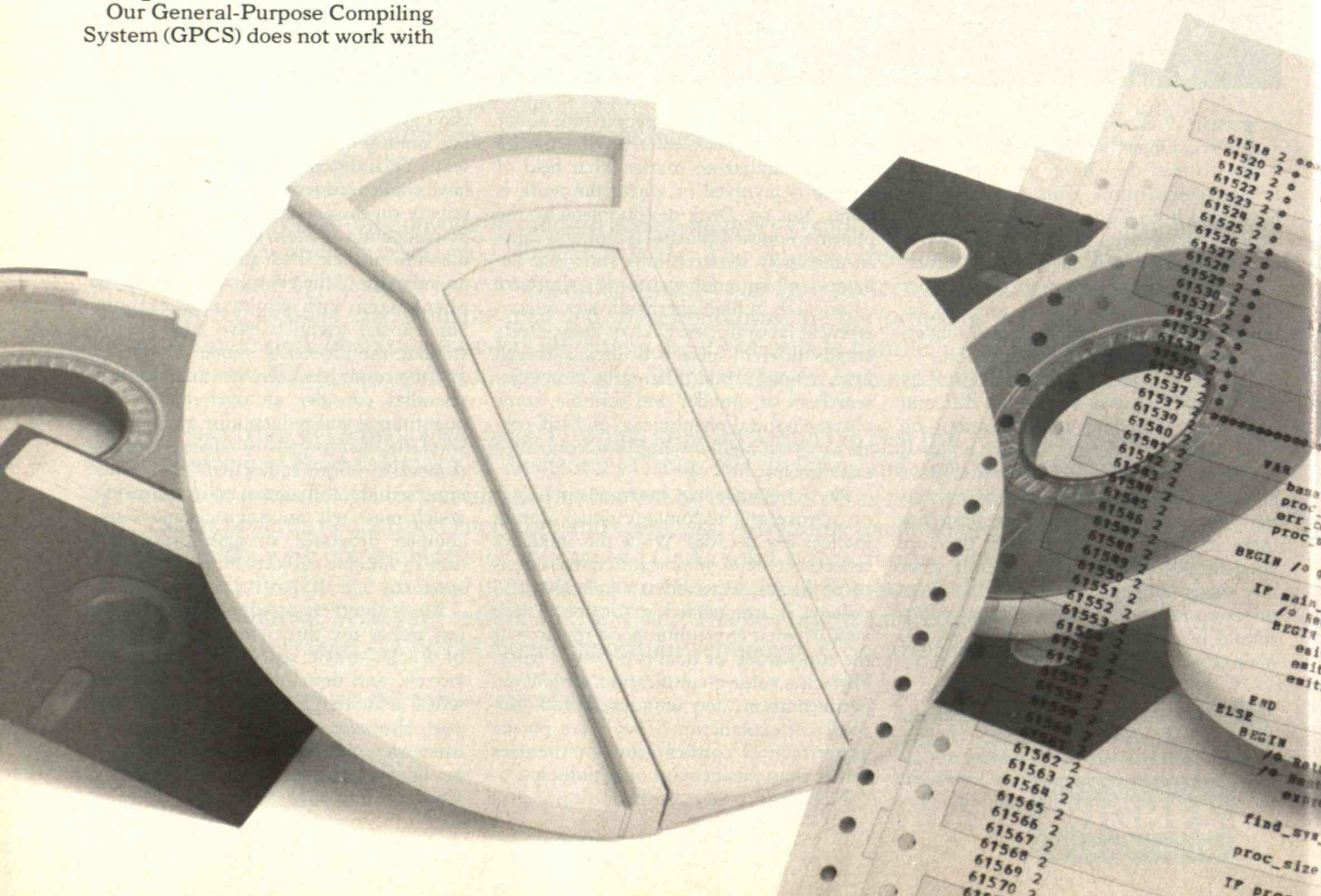
The demand for more and more function has inevitably led to higher costs for designing very large-scale integrated circuits. Designing a 32-bit microprocessor with today's tools, for instance, can take over 100 man-years. Our silicon compiler project promises to reduce this time by 90 to 95 percent.

Using this design-automation tool, designers will describe what the circuit should do functionally, rather than graphically. The tool will translate (compile) requests into appropriate geometry without the laborious circuit layout and routing formerly required.

It is interesting to note that this project may result in the use of custom-logic circuits where microprocessors are used today. After all, when VLSI circuits become cheap and easy enough to produce, it may be preferable to integrate them into systems rather than write software for a microprocessor.



creates software.

Simplifying database access.

With the advent of communications networks like GTE Telenet, many databases have become accessible at relatively low cost. Each, however, may have its own access control mechanism, command language, and output format; and users may want to switch from one database to another with a transparent interface.

We have been working on a way for data-network subscribers to use natural language, which is translated into the various formats required by the different database services. It is called FRED—Front End for Databases. This technology incorporates natural-language processing and the expert systems areas of Artificial Intelligence.

FRED acts like a librarian. It recognizes the meaning of natural-language input and sends a request to the appropriate database.

Not all our computer science projects have the drama of artificial intelligence research, of course. However, our goal in all these investigations is to create software to help improve quality and productivity for advanced communications products and services.

The box at the right lists some of the pertinent papers GTE people have published on software and related subjects. For any of these you are invited to write GTE Marketing Services Center, Department TPIIIC, 70 Empire Drive, West Seneca, NY 14224 or call 1-800-828-7280 (in N.Y. State 1-800-462-1075).

Pertinent Papers.

The System Compiler, 1983 IEEE International Symposium on Circuits.

The MacPitts Silicon Compiler: A View from the Telecommunications Industry, VLSI Design, May-June, 1983.

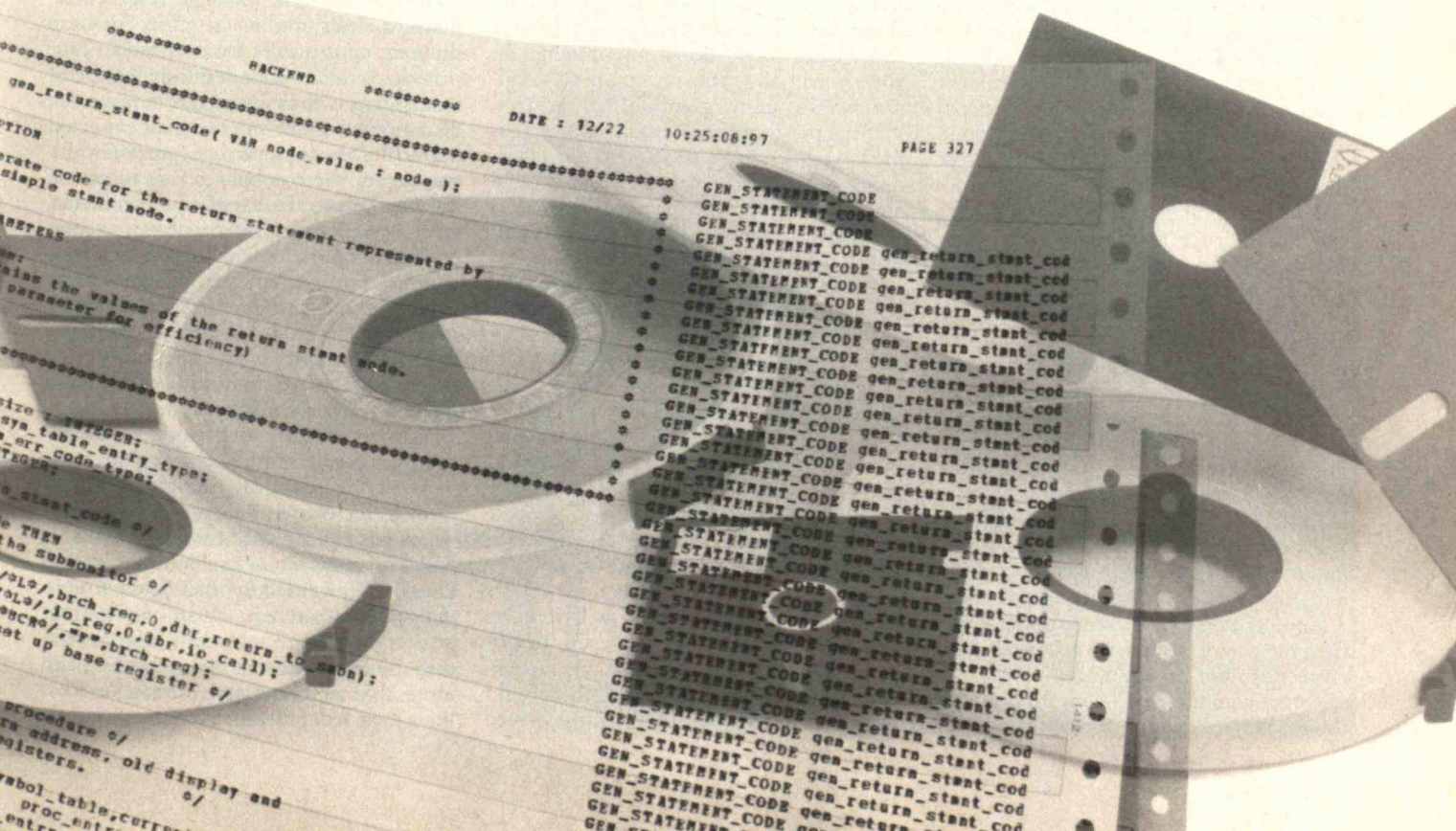
An Intelligent Communication Assistant for Databases, Proceedings of the IEEE COMPSAC 83.

A Natural Language Interface for Medical Information Retrieval, AAMSI Congress, Computer Applications in Medicine.

Separate Compilation for Block Structured Languages: A Comparative Study of CHILL and Ada Compiling Systems, Proceedings of the IEEE Symposium on Application and Assessment of Automated Tools for Software Development.

An Efficient Compilation Strategy for Very Large Programs, ACM SIGPLAN 82 Symposium on Compiler Construction, June, 1982.

GTE



Too high a success rate for government-funded projects may be evidence of insufficient risk taking.

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defined as the disciplined search for knowledge and understanding without regard to the utility of the results. I would suggest that under this definition, very little basic research is being done in the United States today. It's hard to imagine that molecular biologists aren't thinking in terms of curing diseases or splicing genes for commercial exploitation. Perhaps only cosmology and high-energy physics fall into the category of basic research, and even then much research in these fields is justified, if not motivated, by the thought that the discoveries may ultimately prove useful.

On the other hand, R&D programs intended to develop ideas into products, or to solve important social problems, can enhance our fundamental understanding of the universe. For example, research on improving combustion in automobile engines can reveal new insights into basic principles of molecular bonding. But because such studies are motivated by practical concerns, they are labeled "applied research" and are often not considered appropriate for federal support.

It is one thing to use the existing categories of R&D as the framework for determining the health of science and technology. It is quite another to use the categories to decide the "appropriateness" of federal policies and programs. Ironically, before World War II, government support for applied research on national problems such as public health and flood control was considered appropriate. Basic research was to be funded by universities and private philanthropy. Not until the National Science Foundation was established in 1950 did federal support for basic research become widely accepted.

Opinions have changed, of course, and the current administration maintains that government should emphasize support for basic research while leaving applied research, on subjects such as alternative energy sources and urban transportation, to the private sector. Yet by basing decisions on these fuzzy R&D categories, we may be overlooking opportunities to support "generic" applied research in areas of vital importance to industry, such as advanced materials and semiconductor fabrication.

Another premise of science policy is that the best way to support R&D is for government to put up the money and for the scientific community to allocate it among topics, projects, and investigators. In reality, of course, government employees allocate most federal R&D money with the advice of selected members of the scientific community. Persuading scientists to formally choose priorities among the various problems and fields of science is nearly impossible. At best, each discipline is willing to recommend priorities only for itself—with the first priority usually being greater overall spending. The result is that priorities are set largely by government officials informally and indirectly. While this approach preserves the influence of the bureaucracy and the scientific elite, it may be less responsive to changing national needs than a process that more openly considers the views of policymakers and a wider range of scientists.

A related premise is that industry is better than government at choosing "winning" technologies. The fact is that government does try to pick winning technologies every day in areas such as defense, health, the environment, and space. And nurturing multiple approaches to the same goal appears to be more effective than selecting one approach early on. Indeed, one reason that industry appears to be so skillful at picking winners is that different firms make different choices, so that at least one is likely to pan out. Of course, we read in *Business Week* only about the successful outcomes; the poor choices are rarely heard about again. In government, the opposite is often true; failure receives more attention than success.

If the participation of many choosers is the key to a successful strategy for developing technology, we must be careful about accepting the premise that it is wasteful for firms to duplicate R&D efforts and more efficient for them to cooperate. Despite the pressure of foreign competition, we may want to continue to encourage vigorous, technology-based rivalry among domestic firms.

Another popular premise is that private-sector decisions about R&D funding are best guided by investment analysis and public-sector decisions by its close relative—cost-benefit analysis. However, the more an R&D project is designed to make major progress, the more difficult estimating its costs and ultimate benefits becomes. Risk-averse decision makers guided by formal analysis will tend to avoid supporting studies that aim to discover radically new information. For example, some experts in the 1940s thought that there might be a market in the United States for about 10 computers. Subjecting early federal research on computers to a cost-benefit test might well have stopped that work altogether.

Decisions about the significance of R&D programs are at best informed gambles. We should expect a high failure rate for individual projects in government research programs, on the grounds that a high success rate may be evidence of insufficient risk taking.

It is now popular to characterize the Nixon, Ford, and Carter R&D programs on energy as expensive failures—evidence that government makes major errors when it tries to choose winning technologies. Yet such programs appear unnecessary now only because the price of oil has turned out to be much lower than many people expected. In light of conditions when these decisions were made, it is difficult to argue that they were mistakes.

Hand-to-Mouth Funding

Competitive project grants awarded to individual investigators through peer review are considered the best way to support R&D, especially basic research. Yet critics charge that peer review and project grants favor an old-boy network, discourage innovative research, divulge researchers' plans to rivals, and waste effort spent on drawing up unsuccessful proposals.

Perhaps the most undesirable feature of this system is that investigators are often discouraged from pursuing unexpected opportunities for practical purposes. Instead, they are too busy trying to obtain the next grant. To avoid such problems, we may want to consider a system of competitive support for institutions or investigators rather than for projects, with relatively long-term funding commitments to cover salaries and incidental expenses. Purchases of large equipment, unusual travel, and the like could still be supported through short-term grants.

Many state universities and federal laboratories support research in just this way. Federal support for medical research through the National Institutes of Health, which has yielded such enviable results, is based on a system of much longer grants than those awarded in other fields. And in industry, researchers must justify their projects but not usually their salaries, and they are less burdened with reporting and more able to follow new ideas to market than their federally supported colleagues.

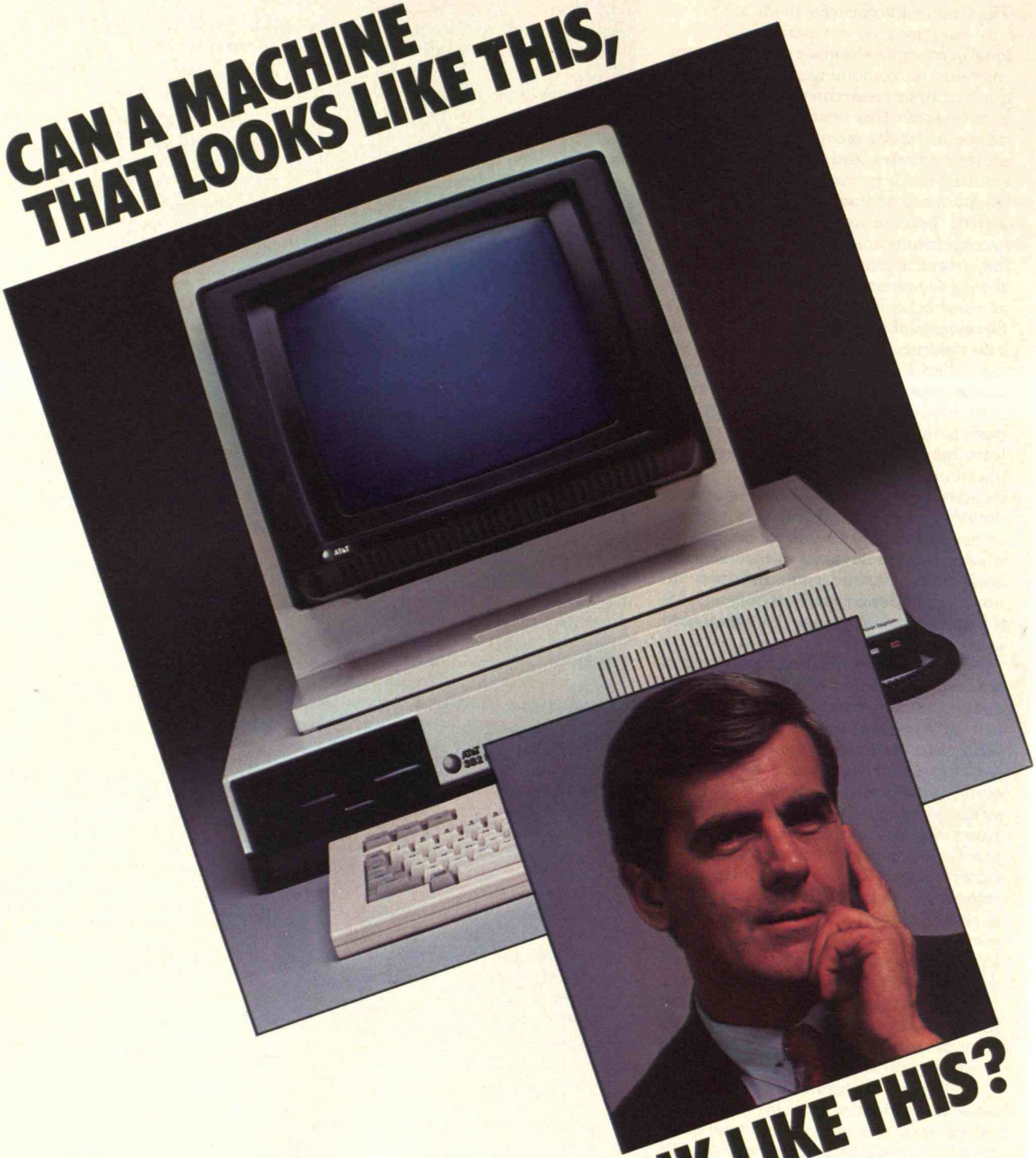
The Cult of Excellence

Finally, a case can be made that the current emphasis on combining graduate education and basic research at U.S. universities is misguided. This system diverts the attention of faculty members from teaching undergraduates and improperly trains graduate students to make optimal contributions to industry, government, and society. Because many science and engineering faculty members are not teachers but research entrepreneurs, they shortchange the numerous engineers who stop at the bachelor-of-science degree. Furthermore, only a small fraction of graduate students pursue careers in basic research, so a two-to-five year apprenticeship in basic research is not necessarily the best way to train them. While there is merit to the argument that students should learn the fundamentals in school and applications on the job, learning the fundamentals need not be synonymous with doing fundamental research. Graduate students often learn work habits and attitudes that are ill-suited to the industrial environment. At the same time, they do not learn the design, problem-solving, production, and managerial skills they need in industry.

No one opposes the training of our best students to do the finest possible scientific and technical work. But in my view, the cult of excellence has led us seriously astray over the last 25 years—not because we have failed to produce excellent research scientists, but because we have left so many other graduates inadequately prepared. We have problems coping with the pressures of international competition partly because the U.S. workforce is not sufficiently prepared to reason quantitatively and understand the rudiments of science and technology. By contrast, the Japanese try to ensure that all students perform at an acceptable level, and they focus less on catering to the excellent few. Their success suggests that we could learn some important lessons about Japanese "quality control" in education.

In deciding the future course of our science and technology policy, we need to take a hard look at many of the premises that have guided R&D and graduate education in the United States. We must make certain that we don't use our concern for international competitiveness as a convenient rationale for reinforcing the very systems that may require change. □

CAN A MACHINE THAT LOOKS LIKE THIS,



THINK LIKE THIS?

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Computers only look smart. Actually, they can't tell the players, or anything else, without a program.

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At AT&T Bell Laboratories, using the new approaches to computer programming of knowledge engineering and rule-based programming, we have developed software that can cope—like a human—with incomplete and uncertain information, such as incorrect spelling and improper abbreviations.

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Called expert systems, this ambiguity-tolerant software is a new approach to artificial intelligence in industry. And, like the subject matter experts it mimics, our first expert system, ACE, works with equivocal data, but produces expert judgments.

ACE, for "Automated Cable Expertise," is a software system that contains the distilled knowledge—in the form of "if-then" rules—of the people who know cables best: telephone company cable maintenance experts. ACE differs from other expert systems in two ways: it manipulates massive amounts of data, and driven by the UNIX™ Operating System on a 3B2 computer, it obtains this information automatically from the data bases of other computers.

Developmental ACE software has been working as an "assistant" for over two years now to the cable maintenance force of the Southwestern Bell Telephone Company. Every night it monitors and analyzes the performance of cable systems serving over half-a-million customers in several metropolitan areas.

But ACE does more than analyze; it makes recommendations.

The Expert at Work

Unlike a conventional computer system, ACE isn't programmed with all logical answers to all possible problems. Instead, it's given a set of about 500 rules to follow.

ACE can run through the cable records of a city the size of Fort Worth overnight, a job that would take a human up to a week. By collecting its information from other computer programs, detecting recurring patterns, requesting additional data, and testing these data against its expert-derived rules, ACE can often isolate problems much earlier than its human counterparts. It provides information on both specific trouble types and locations—such as a break in cable insulation at the corner of 3rd and Elm. And when ACE has a recommendation to make, rather than generating a mound of paper, it communicates via a CRT.

ACE frees humans to work on the causes of problems, not the symptoms.

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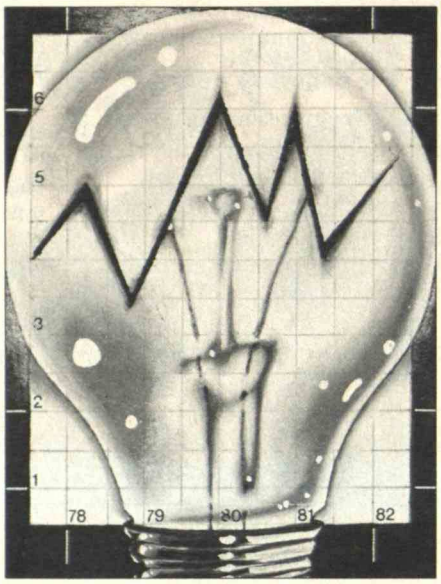
Utility Battles, Inside the Arms Race, and Employee-Run Firms

Transforming the Electric Utility Industry

Dynamos and Virgins
by David Roe
Random House, $18.95

Reviewed by Richard F. Hirsh



Regulating electric utilities used to be a polite activity that entailed ratifying decisions already made by power companies. State regulatory bodies, created largely by utilities themselves early in the twentieth century to legitimize their monopoly status, were usually understaffed and poorly equipped to handle conflicts over the rates they allowed power companies to charge. However, few such conflicts arose as utilities pursued a program of promoting electricity use, building large, centralized power plants, and continually bringing down the unit cost of their product.

This benign concept of electricity regulation changed entirely in the 1970s as power companies battled advocates of conservation, "no growth," and antinuclear policies. In *Dynamos and Virgins*, David Roe provides an insider's view of one episode from this era of confrontation. A lawyer for the Environmental Defense Fund (EDF), Roe and his colleagues are the "good guys" in what he portrays as a classic confrontation between the champions of the public good and an evil corporate giant, California's Pacific Gas and Electric Co. (PG&E).

Early in the 1970s, PG&E projected that growth in electricity demand would require construction of five nuclear power plants in the next decade. The EDF maintained that the utility could provide adequate service by reducing electricity demand through conservation and buying extra power from small, decentralized producers. The environmentalists used a novel tactic for a public-interest group, arguing that PG&E should adopt this approach not because it supported a "soft energy" philosophy of "small is better" but because the plan made good business sense. Avoiding the rhetoric of the conservation movement, the EDF developed a computerized planning model that incorporated the standard tools of financial forecasting.

Utility executives, unaccustomed to sharing decision making, reacted defensively and hired high-powered computer consultants to discredit the model. Roe maintains that these consultants succeeded only in proving the model's validity when their objections proved to be unfounded. Even after five years of hearings, state regulators refused to order PG&E to employ the novel strategies, but the utility did eventually adopt many of them. It implemented aggressive conservation strategies, turned to cogenerators and windmill operators for extra power, and canceled plans to build the proposed nuclear plants. PG&E officials admitted that the EDF influenced their decisions, but they also pointed out that the declining growth rate in electricity demand made new plants unnecessary.

Roe presents what he admits is a skewed view of the utility managers as incompetents at best and villains at worst. However, he does not provide reasons for their hostile reactions. It's no wonder that they felt embattled. After all, they were proud of their industry's hundred-year effort to make access to electricity a right for all Americans. The utilities succeeded in this effort by taking advantage of improving power technology. The thermal efficiency of power plants increased 20-fold from the 1890s to the 1960s and their capacity grew 1,000-fold, yielding tremendous economies of scale. The average residential customer paid only $.02 for a unit of electricity in 1969 that cost over $1 in 1892 (in real terms). Thus, utility managers considered themselves socially responsible stewards of technological progress who provided a commodity that improved people's standards of living.

This situation changed in the 1960s, as thermal efficiencies reached their limit and improvements in scale economies ground to a halt when big new power plants didn't operate as expected. The country's most capital-intensive industry also faced financial nightmares as inflation increased the cost of borrowing money. Conservationists added to utilities' woes by opposing construction of power plants, arguing that precious vistas and natural resources would be defiled. Meanwhile, regulators required utilities to use expensive equipment to scrub waste gases and cool wastewater. Caught between public demands and pressure from utilities, regulatory agencies often denied power companies' requests for increased rates.

Thus, while PG&E wouldn't admit it and the EDF didn't know it, the environmental group represented all these external forces challenging the executives' traditional mode of operation. Seen in retrospect, the EDF's strategy eventually worked, but company executives could not change overnight.

The book ends on a sanguine note, lauding the fact that utilities across the country have begun to adopt soft energy paths. However, one wonders how long this strategy can work. Even with conservation, alternative energy sources, and low growth in electricity demand, many power plants built in the 1950s will soon have to be replaced. Because new plants and alternative technologies require up to a decade to be installed, the future reliability and cost of alternative energy supplies are still uncertain. Even many EDF sympathizers admit that some of the wind farms that promised to provide electricity to PG&E have yielded more tax breaks for investors than energy for customers.

Roe leaves the reader wondering whether utility managers have truly become converts to their new religion, or whether they are simply reciting its scripture until their old wisdom is vindicated. Although utility executives are now paying homage to the symbol of the environmentalists' virgin, they may be waiting silently until they can resurrect the dynamo and worship it again without shame. □

RICHARD F. HIRSH is associate professor of the history of technology at Virginia Polytechnic Institute and a research fellow at the Harvard Business School.

An Intimate View of the Arms Race

Nuclear Hostages
by Bernard O'Keefe
Houghton Mifflin, $14.95

Reviewed by Herbert Lin

Nuclear Hostages concerns the personal saga and political opinions of a man who has spent much of his life assembling and testing nuclear weapons. Author Bernard O'Keefe's views span the political spectrum. Some are hawkish: the Soviets would cheat on a nuclear freeze; the Soviet system is morally and economically bankrupt; the West can force economic and therefore political change on the Soviet Union. Others are dovish: civil defense cannot work; new tactical nuclear missiles in Europe should not be deployed; reconciliation between the superpowers is essential. The surprise—and the message of hope—lies in the fact that even someone who has put so much effort into developing nuclear weapons can see the danger of the arms race.

O'Keefe's personal anecdotes are his most valuable contribution. Not only do they give the reader a vivid sense of what it was like to participate in the Manhattan Project; they also document how a hard-boiled naval officer and militant anticommunist can be changed forever by intimate experience with nuclear weapons.

For example, O'Keefe relates how he discovered at the last minute that the Fat Man implosion bomb—the one that would eventually be used at Nagasaki—had been wired incorrectly in the rush to assemble it before bad weather set in. He was able to correct the problem only by breaking regulations; for those few moments he was determining history, and his anguish is palpable.

His description of the testing of a tactical nuclear artillery shell is equally compelling. "I watched the fireball churning its way up into the sky, visible for 50 miles around. Then the shock wave, very powerful in the [safety] trench, rattling windows in Las Vegas, 90 miles away. The first flash would sear the eyeballs of anyone looking in that direction, friend or foe, for miles around. Its intensity cannot be described; it must be experienced to be appreciated."

With memories such as these, O'Keefe understands nuclear weapons in a profound way. He notes that few people alive have seen a nuclear explosion, including most military and civilian leaders in both the United States and the Soviet Union. It is sometimes proposed that the Limited Test Ban Treaty be amended to allow one atmospheric explosion every decade. That way world leaders could observe firsthand the enormous power of nuclear weapons and thus take a more sober view of nuclear war. O'Keefe's experience lends credibility to such an idea.

Beating the Drums

Unfortunately, O'Keefe's social, political, and military analyses are less compelling. He repeatedly points to the development of nuclear weapons as inevitable. For example, he concludes that domestic political pressures forced President Truman to decide to drop the atomic bombs on Japan. He also maintains that public opinion forced Truman to endorse the crash program to develop the superbomb—thermonuclear hydrogen weapons—after the war.

Public opinion is undoubtedly influential in such matters, but political courage should have a role as well. Truman could have encouraged public debate about the need, or lack thereof, for a program to develop the H-bomb. After all, Truman's own General Advisory Committee had unanimously recommended that the United States refrain from proceeding with a crash program. Truman could also have advocated developing smaller tactical nuclear weapons instead of the H-bomb. Perhaps the arms race would have occurred anyway, but history suggests that we didn't even try to slow it down very often.

Even while saying that the United States had no choice but to proceed down the nuclear path, O'Keefe suggests that the Soviet Union behaved improperly in developing nuclear weapons. "While Americans searched their souls about continuing after Hiroshima and Nagasaki, the Soviets plunged ahead without a twinge of conscience. While our nuclear research capability eroded in 1945 and 1946, they managed to achieve criticality [of their atomic pile] before our Atomic Energy Commission became operational. Nothing we could have said or done would have dissuaded them." Yet could any Soviet leader have dared suggest that the USSR allow the United States a monopoly on nuclear weapons?

Despite the apparent inexorability of the arms race, the United States and the Soviet Union tried to achieve a comprehensive ban against nuclear testing from 1958 to 1963. President Eisenhower initiated a moratorium on testing in 1958. However, the Soviets resumed testing in 1961—a response O'Keefe considers "an act of perfidy" violating the moratorium. Yet Eisenhower had notified the USSR in 1959 that the United States was no longer bound by the moratorium. Moreover, the Soviet testing did not affect U.S. security, as the early 1960s were a time of massive American nuclear superiority. President Kennedy could have taken the lead in educating the public about U.S. superiority, rather than giving in to "the political imperative" to resume U.S. testing as well. Presidents need not beat the drums along with the rest of the country.

O'Keefe's knowledge of technical military issues is spotty at best. He believes that an enemy would use nuclear weapons over a wide area even when aiming for specific military targets to ensure against inaccuracies. He maintains that Soviet missiles can be reprogrammed to attack new targets in less than an hour. He believes that nuclear parity is necessary if each side is to have enough firepower to survive a first strike and go on to annihilate the aggressor. Yet nuclear weapons and their delivery systems are simply too expensive to be produced for barrage at-

ILLUSTRATIONS: EUGENE YELCHIN

Gunn's book is an important reminder that not all the sixties' kids ended up in a big chill.

tack; that is why both sides have steadily improved the accuracy of their missiles over the years. Soviet missiles can probably not be reprogrammed quickly; even changing the trajectory of most U.S. ICBMs takes longer than an hour. And nuclear parity is unnecessary for deterrence; even a small arsenal can be designed to survive an attack.

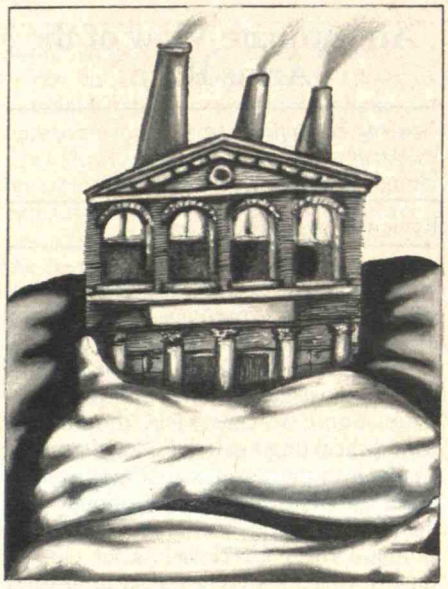
Finally, his solutions are polemical. He advocates increased understanding of the Soviet Union and more trade between the superpowers as a route to improved political relations. Certainly those goals are desirable, but O'Keefe offers minimal guidance about how to achieve them. Thus, *Nuclear Hostages* is worth reading for O'Keefe's personal look into the arms race, but citing him as an authoritative source on matters of nuclear strategy or political necessity would be unwise. □

HERBERT LIN is a postdoctoral fellow in the Center for International Studies at M.I.T.

Promoting Employee-Run Firms

Workers' Self-Management in the United States
by Christopher Eaton Gunn
Cornell University Press, $25

Reviewed by Karen Rosenberg



The spectre of plant shutdowns during the recent severe recession has made employee ownership a more familiar concept in this country. The term generally conjures up a bleak scenario: workers too old to retrain, living in a depressed region and employed in a declining industry or a plant with a profit rate that doesn't satisfy top management, agree to substantial cuts in wages and benefits in exchange for the opportunity to buy company stock.

Sometimes called "worker capitalism," employee stock ownership plans—or ESOPs—have been touted as a way to lessen antagonisms between labor and management. However, when workers buy the securities of the firm that employs them, they frequently assume a large risk and gain little control. In many cases they own only a small percentage of the company's stock and do not have input into management decisions. The grievances and strikes by employees at such firms suggest that ESOPs create high expectations that may well cause bitterness and frustration. And unions are beginning to suspect that firms often establish ESOPs at individual plants to undermine national contracts and reinvent the company unions of yore.

In *Workers' Self-Management in the United States*, Christopher Gunn, associate professor of economics at Hobart and William and Smith Colleges, describes a lesser-known way for employees to take over existing firms and also to establish new ones. Proponents of this approach, called "industrial democracy," maintain that ownership should not confer the right to manage. Instead, they argue, each worker should have an equal say in how a firm is run. Advocates view industrial democracy as extending the right of political self-determination to the workplace.

Although worker self-management can be considered radical in that it questions the foundations of the U.S. economic system, it does not square with socialism's state ownership of the means of production and distribution. Instead, partisans call for a "third way" exemplified by the Mondragon group of cooperatives in Spain, founded by Father José Maria Arizmendi in 1956. Mondragon's 20,000 workers produce a range of consumer goods from refrigerators to machine tools.

The number of effective cooperatives on this side of the Atlantic is growing, and Gunn offers several U.S. examples, including the plywood-manufacturing cooperatives in the Pacific Northwest. These firms, which have operated for 60 years in relative obscurity, have failed to satisfy many self-management purists because they hire nonmembers as employees, maintain hierarchical relations on the shop floor, and sell shares for as much as $100,000. Gunn is sympathetic to their efforts but he does not ignore their failure to set aside enough money for investment rather than income—a traditional problem for self-managed firms.

A number of cooperatives emerged from the sixties' counterculture, as Gunn describes. Organizers viewed these enterprises as vehicles for overcoming social alienation, encouraging personal growth, and promoting gender equality, as well as for making a profit. Hoedad, a forest workers' coop headquartered in Eugene, Ore., still fields crews with names such as Cheap Thrills, Red Star, and P.F. Flyers, while Marmot Construction Works of Seattle puts out a newsletter "published in the center of chaos of the great feedback loop." Proponents of worker self-man-

agement, anxious to gain support for their cause, often downplay such details, but surely the hippies of yesteryear deserve credit for the success of these ventures. And the fact that white, middle-class, college-educated youth founded them does not negate their relevance to other groups. Gunn's book is also an important reminder that not all the idealistic kids of the sixties ended up in a big chill.

Both capitalist and socialist theorists often doubt the viability of employee-owned enterprises, because they assume that workers are not capable of managing effectively. A growing number of studies shows that productivity increases as workers' participation in an organization rises, but such evidence will not convince skeptics. Perhaps to encourage others to join their faith, many advocates of employee-run enterprises, including Gunn, succumb to hyperbole; some seem to promote trips to Mondragon as visits to Mecca. That may be the cost of maintaining a minority opinion in a hostile environment.

Gunn does admit that those attempting to put the theory of self-management into practice in the United States face formidable obstacles. Few mechanisms exist for educating workers for their management roles, and sharing information among employee-run firms is difficult given the scarcity of funds for that purpose. Organizations such as the Industrial Cooperative Association, based in Somerville, Mass., are trying to fill this need. Also, the role of unions in self-managed enterprises remains unclear, as many such firms—including most of the plywood-manufacturing cooperatives—operate outside union jurisdiction. And diversification within or outside an industry may be necessary for a firm's survival, yet Gunn cites few examples of self-managed enterprises that have followed that route.

Gunn advocates establishing federal grant and loan programs to help cooperatives finance expansion, and setting up organizations to advise them on financial decisions. He would like to see a long-term coalition of environmentalists, feminists, grass-roots organizers, and union activists encourage these innovations. However, neither effort appears to be on the immediate horizon. □

KAREN ROSENBERG is a fellow of the Russian Research Center at Harvard University and writes widely on the politics of culture.

Silver Satellites

BY DIANE JOHNSON

On April 1, 1960, our view of the world changed irrevocably. From its vantage point in space, the first U.S. weather satellite pictured an earth with no national boundaries—only the demarcations of ocean shorelines and mountain ranges, polar ice caps and river deltas. The powerful image opened the way for a new understanding: we all inhabit a fragile planet with finite resources. Buckminster Fuller later crystalized this changed perspective, popularizing the idea of Spaceship Earth.

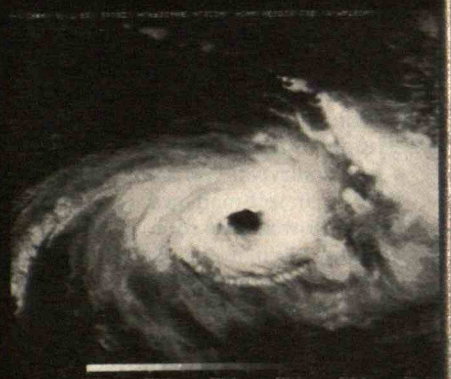
The pioneering satellite—TIROS, for Television and Infrared Observation Satellite—emerged from a spirit of worldwide cooperation. Individual nations had long recognized they could not produce accurate weather forecasts based only on information gathered within their own borders. Said Henry Wexler, then research director of the U.S. Weather Bureau: "There are many things that meteorologists do not know, but of this they are sure—that the atmosphere is indivisible, and that meteorological events occurring far away will ultimately affect local weather."

The TIROS pictures, crude by today's standards, delighted many meteorologists. The huge, inward-curling commas of tropical hurricanes, the steady march of Pacific storms that battered the Western coastline, the meandering river of globe-circling jet stream clouds—all were new images. Even skeptics who questioned the value of "pretty cloud pictures" were gradually won over by TIROS and its increasingly sophisticated successors.

"Before the advent of satellites, weather observations were available for less than one-fifth of the globe," says Patrick Hughes, of the National Environmental Satellite, Data, and Information Service, in *Weatherwise* magazine. "Little if any information was available for the polar regions or vast stretches of Asia, Africa, and South America." Over the oceans, tropical storms formed and grew to maturity undetected until they sank a ship or savaged a coastline. "Today," Hughes says, "satellites provide practically continuous monitoring of the atmosphere on a global scale, allowing meteorologists of all nations to follow the ebb and flow of worldwide weather patterns."

DIANE JOHNSON is director of science communications at the University of Colorado.

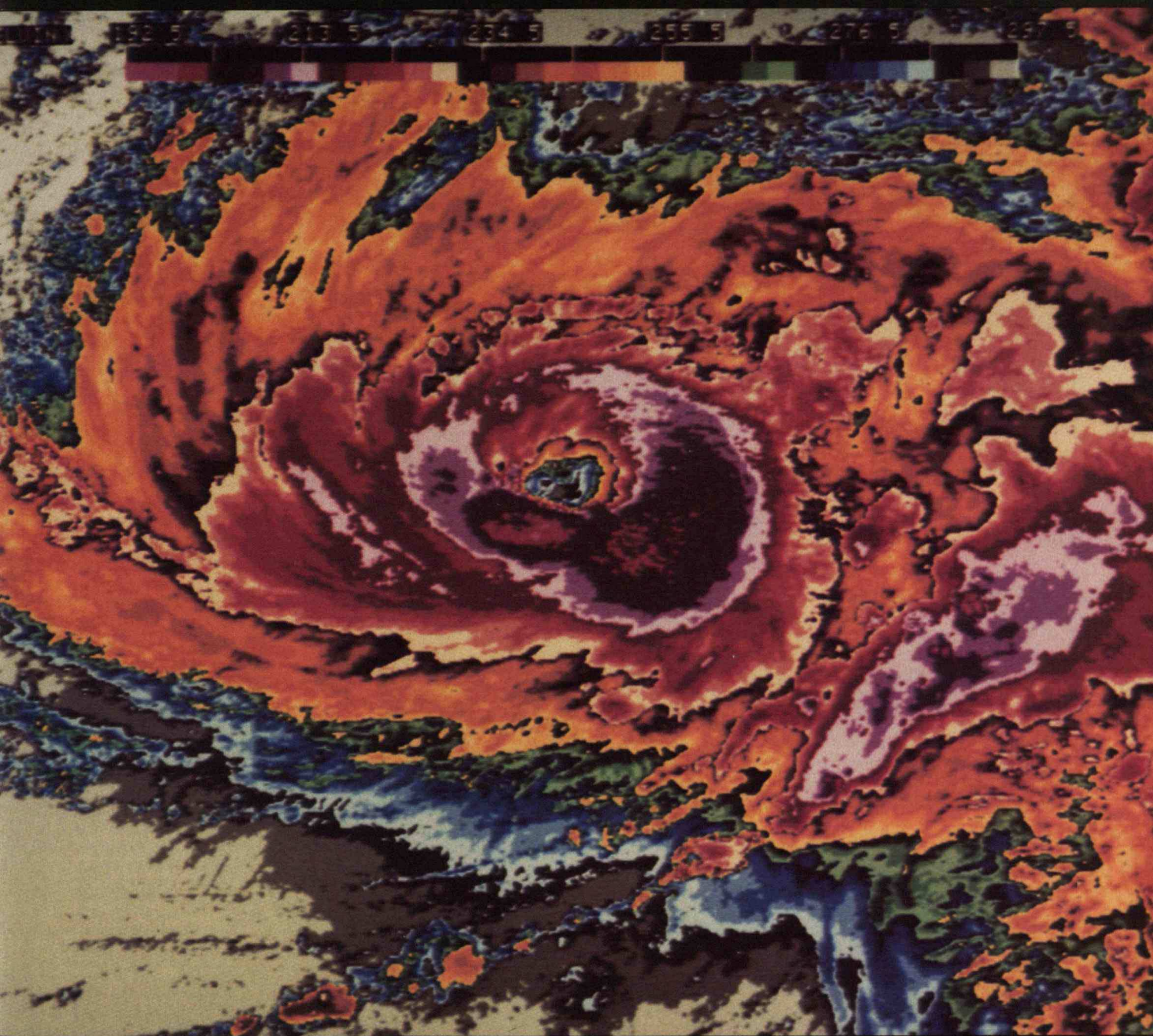
Now celebrating their 25th anniversary, weather satellites do far more than serve meteorologists. The forecast calls for even greater capabilities and international cooperation.



Tracking hurricanes and other violent tropical storms throughout the world is one of the most important jobs of weather satellites.

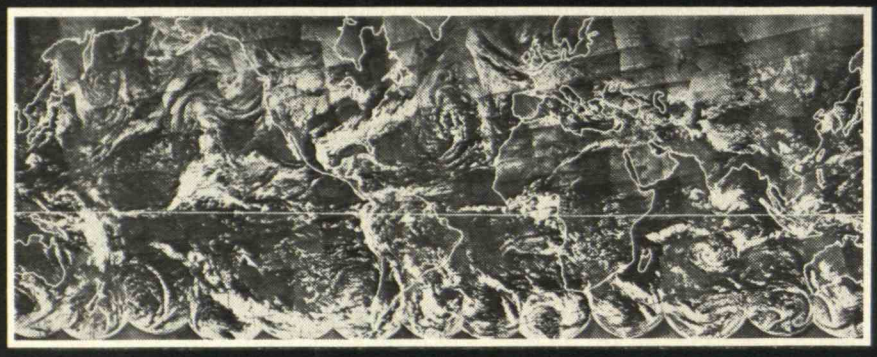
A U.S. polar-orbiting satellite snapped this infrared image of Hurricane Alicia on August 17, 1983 (right). The computer-generated colors show temperatures at the cloud tops—an indicator of cloud thickness. The eye of the storm was 60 miles south of Galveston, Tex., and winds wailed at 100 miles per hour.

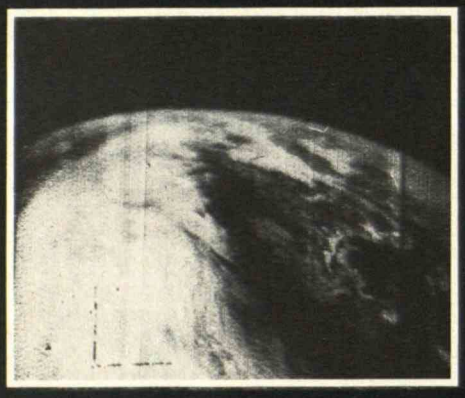
The satellite also produced water-vapor images of Alicia. These help forecasters gauge atmospheric circulation in the vicinity of a storm (below).



PHOTOGRAPHS: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The first complete picture of the world's weather—a "photomosaic" made from 450 individual images taken by a polar-orbiting satellite—was produced on February 13, 1965 (below).





The pioneering TIROS weather satellite sent its first fuzzy picture to earth on April 1, 1960 (left). Today global satellite photos are nearly taken for granted (right).

Indeed, the American Meteorological Society recently declared that satellites have contributed significantly to increasing the accuracy of weather forecasts covering periods of one to five days. Moreover, the variety of useful data provided by weather satellites has triggered a revolution that is still underway in fields ranging from crop-yield forecasts to emergency rescue.

Shepherding the U.S. network of satellites is the job of the National Oceanic and Atmospheric Administration (NOAA), part of the Department of Commerce. NOAA maintains two complementary weather satellite systems, earning it the nickname "the other space agency":

☐ Two polar-orbiting satellites loop around the earth 14 times a day at an altitude of about 500 miles. Since the earth spins as these satellites travel from pole to pole, each craft passes over every geographical location twice a day, providing a steady global view of weather and surface conditions.

☐ Geostationary satellites keep a closer eye on North and South America and the adjacent oceans. These satellites hover steadfastly above the equator at an altitude of 22,300 miles, moving with the earth so they remain at a fixed position relative to its surface. They beam down "full-disc" pictures of the earth every 30 minutes and partial pictures more frequently to monitor the development and movement of severe storms.

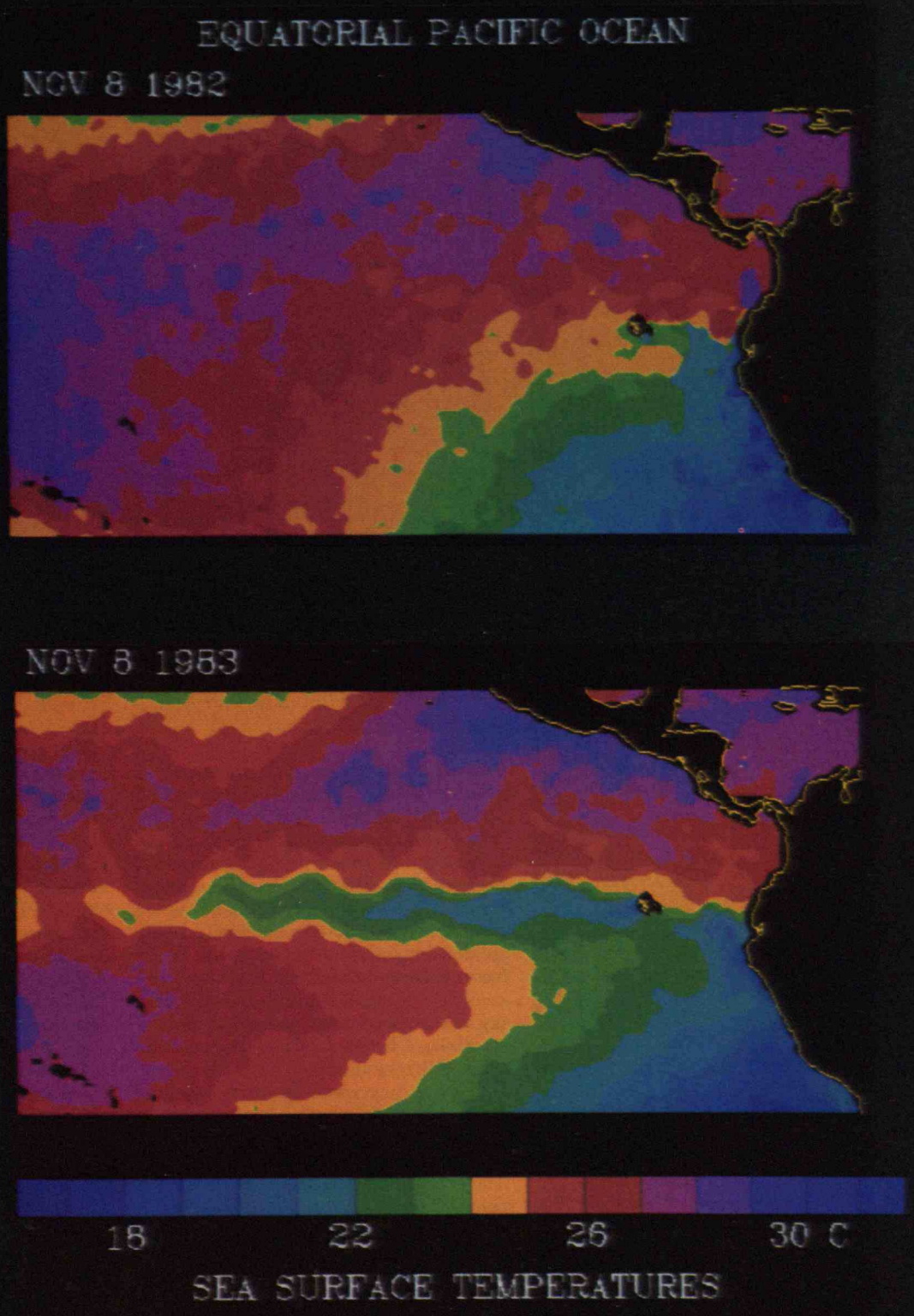
Two Geostationary Operational Environmental Satellites, or GOES, are usually at work. But at the moment only one is fully operational. GOES-East, which kept an eye on North and South America and the Atlantic Ocean, failed last summer. NOAA reinstated GOES-1, the oldest weather satellite, which was still in orbit but not on active duty, to take its place. GOES-1 long ago lost its ability to take pictures at night, but a one-eyed satellite was deemed better than none. However, GOES-1 failed completely in February. NOAA therefore plans to shift the location of GOES-West, which normally monitors North America and the Pacific, to provide a more centralized view. NOAA had originally planned to replace GOES-East with another satellite—aptly called GOES-Next—by spring of 1986, but now hopes to meet a late-1985 launch date.

Both polar-orbiting and geostationary satellites use a host of instruments—operating in the visible, infrared, and microwave spectrums—to monitor various levels of the atmosphere as well as surface conditions. The spacecraft also collect and relay data radioed to them from thousands of automatic instruments, platforms, buoys, and balloons located throughout the world.

U.S. weather satellites are not alone in space. Japan, India, the Soviet Union, and the European Space Agency maintain geostationary and polar-orbiting satellites that feed data earthward. Many other nations, including Canada, Great Britain, and France, provide instruments carried on the satellites and operate central ground facilities that process and disseminate information.

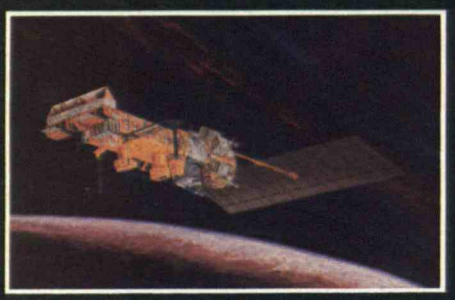
A wealth of data and imagery thus streams earthward every day. This information is available to all, making weather satellites one of the few systems in the world that makes no distinction between the "have" and "have-not" countries. "More than 120 nations receive data directly from the satellites, and nearly all nations receive data via links coordinated by the U.N.'s World Meteorological Organization," says John McElroy, director of NOAA's satellite service. "This means that essential weather information is available several times a day at no cost beyond that required for the relatively simple equipment needed to receive signals."

More than 1,000 stations around the world are known to be receiving data from weather satellites. (There's no accurate count because anyone who wants to plug into the information network can do so



Satellites offer an unequaled ability to monitor sea-surface temperatures, which are an important influence on weather and climate. For example, meteorologists recently used infrared images taken by a polar orbiter to watch the progress of El Niño, a warming of water off the west coast of South America.

The map made in November 1982 shows "normal" sea-surface temperatures (top). A year later, warm waters had taken over the equatorial region (bottom). The warming trend triggered widespread meteorological changes — heavy rain in some areas, drought in others.



When a ship capsizes or an airplane crashes, speedy rescue of the victims often means the difference between life and death. The United States and the Soviet Union now have weather satellites equipped with special antennas that listen for distress signals. The satellites relay signals to ground receiving stations, where workers pinpoint the emergency location and direct rescue crews. The system has already saved more than 350 lives.

without licensing or restrictions.) This easy access to global weather data gave birth to a loose network of technical sophisticates who predate today's computer hackers. Their specialty is finding practical uses for weather information: determining the right conditions for crop dusting, forecasting weather conditions for soaring competitions and balloon flights, predicting the best time to harvest sugar cane in Brazil or dry copra on the island of Tonga, and forecasting production of particular crops to gain an edge in the international commodities market.

Unequaled Views

Indeed, systematic attempts to use global weather data have opened up unexpected horizons. For example, by mapping high-altitude jet streams, commercial airlines can choose the best route for their planes. A 2,300-mile trip against severe headwinds can cost as much as $1,500 more in fuel than the same trip flown in ideal conditions. Applying such information saves airlines an estimated $700 million annually.

Satellites are also used to spot grass fires and forest fires in wilderness regions and track large oil spills in the oceans. They have greatly improved mapping of sea and lake ice and monitoring of seasonal changes in the polar ice cap, aiding wintertime navigators on the Great Lakes and in the Arctic. NOAA uses satellite imagery to monitor snow conditions in the Rocky Mountains and the Sierra Nevada. When snowpack is unusually heavy, spring melting can cause serious flooding, and snow-cover charts help federal and state agencies plan for heavy runoff.

Satellites provide an unequaled view of volcanic eruptions, allowing scientists to monitor and analyze the huge clouds of ash that spread through the stratosphere. The interest is more than theoretical: ash from several recent eruptions has clogged jet airliner engines and caused them to stall. (The planes were still able to land safely.) U.S. and international aviation organizations are now investigating the use of satellites to track volcanic clouds on a regular basis and reroute air traffic.

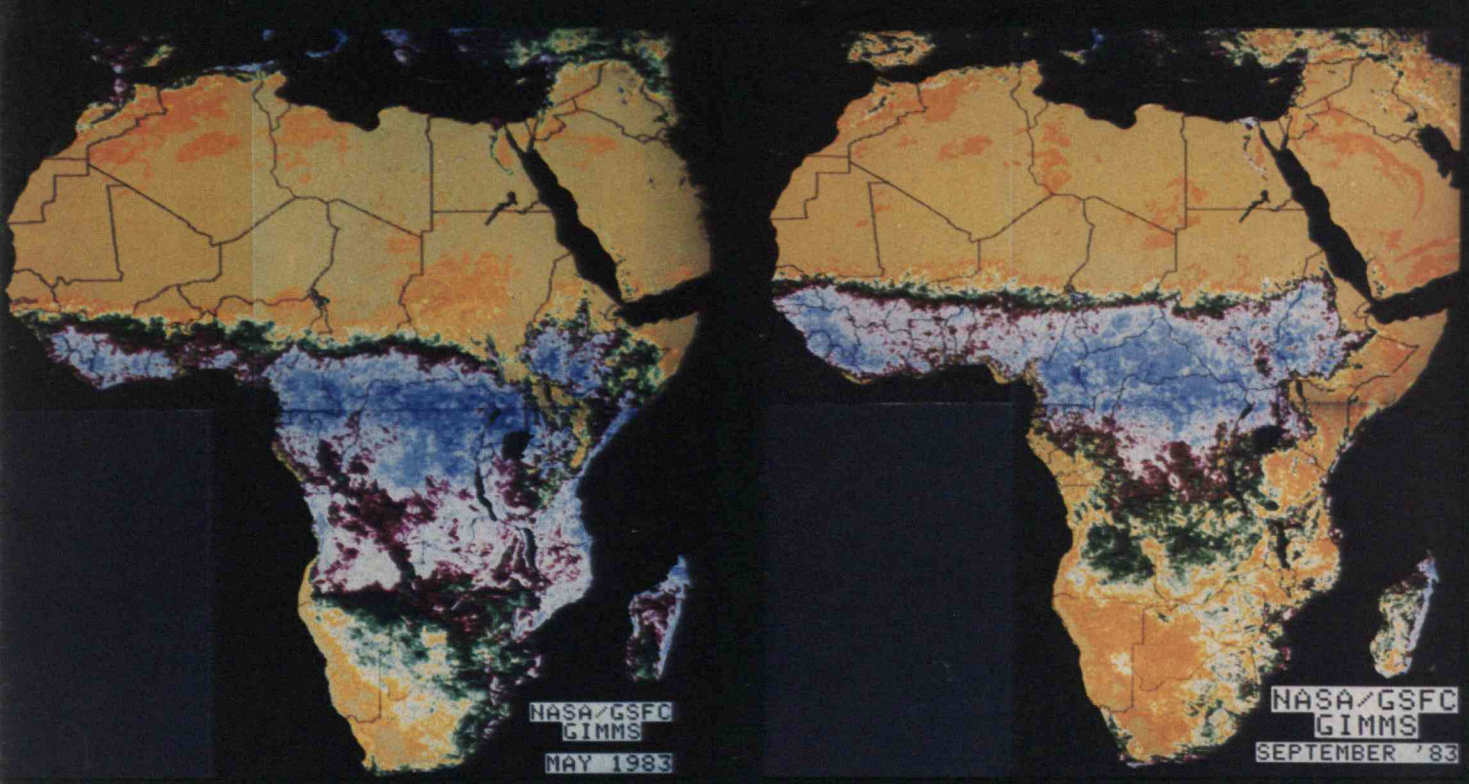
Since 1982, NOAA has been producing weekly national and global "vegetation index" maps. The polar orbiters carry detectors sensitive to chlorophyll, the "green" in plants, and thus can survey the density and vigor of crops and other vegetation. McElroy says the satellites "permit reliable 30-day forecasts of crop yield losses, 60-day alerts of likely price changes, 90-day lead times on import-export decisions, and 90- to 180-day food-shortage forecasts." For example, satellite images predicted and now monitor the drought and food shortages plaguing Ethiopia and other regions of Africa. NOAA provided its information to the governments of all affected nations.

Satellites also provide an unprecedented ability to measure sea-surface temperatures on a regular basis. Researchers need such data to better understand the important link between the oceans and weather and climate. For example, in 1983 El Niño—a widespread warming of water off the west coast of South America—was unusually strong. It was also associated with the heaviest rain and worst flooding in 50 years in Ecuador and Peru; heavy rain in California, Louisiana, and Cuba; and crippling drought in other areas of the world. Being able to predict such changes by "reading" the seas would provide enormous economic and public-safety benefits.

Answering distress calls from ships and aircraft anywhere in the world is the latest international function of the weather satellite network. In a cooperative program, special antennas are piggybacked on polar-orbiting satellites maintained by the Soviet Union and the United States. Canada and France provide major electronic components for the U.S. system, which is called SARSAT (Search and Rescue Satellite-Aided Tracking). The antennas pick up S.O.S. calls from emergency locator beacons carried on board most ships and aircraft.

When a ship capsizes in icy waters or a plane crashes in the wilderness, speedy rescue can mean the difference between life and death. A satellite within 1,600 miles of an emergency beacon receives the S.O.S. almost instantaneously and transmits it to a ground-based receiving station, which in turn pinpoints the emergency location to within a dozen miles and directs rescue crews. SARSAT is already credited with saving more than 350 lives since the program began in mid-1982.

Most places on earth have a satellite within range every two hours. However, receiving stations are located only in the Northern Hemisphere. NOAA is now working with Brazil, Australia, and other nations to expand coverage into the Southern Hemisphere within a year or so.



The U.S. government uses satellite images to produce weekly national and global "vegetation indexes." In these 1983 maps of Africa, the vegetation (green and blue) moves north into the desert (tan) even with the limited rains of such a severe drought year.

NOAA researchers are also testing a new transmitter that operates on a higher frequency than conventional emergency beacons. Because the new signal is stronger and purer, it can be picked up by a satellite, recorded, and then "dumped" when the satellite next passes over a ground station. The new frequency can also transmit more detailed information and will enable rescuers to home in on the location more precisely. "The United States, Canada, and France are just beginning to deploy these transmitters," says McElroy. One such device saved its first life in January—that of a driver who crashed during an auto race across the Sahara desert.

Rescue Troubles

However, SARSAT faces partly cloudy weather. On October 5, 1984, after a long struggle with the White House Office of Management and Budget (OMB), NOAA signed an agreement with the Soviet Union to extend the program at least through 1990. Both nations agreed to provide antennas on two polar-orbiting satellites, but only one U.S. satellite now carries SARSAT equipment.

The rub is that President Reagan and OMB director David Stockman have tried each year to slash the polar-orbiting system down to one satellite as a cost-saving measure. Each year, Congress has restored the money. The administration has again deleted funds in its proposed 1986 budget—though it did include an extra $65 million for the new geostationary satellite. This time some NOAA officials think the cut might stick, though they argue that maintaining a two-satellite system will cost only about 10 percent more.

Still, there is enough money in the current budget to launch one more polar orbiter, scheduled for this summer. The craft will carry SARSAT equipment and replace the older of the two satellites now in orbit, which was placed on standby status in February after serving its expected two-year lifetime. Another option being considered is installing the SARSAT equipment on a "dedicated" satellite designed to cost less and last longer.

Beyond that, NOAA is taking the position that if other nations want to reap the benefits of polar-orbiting satellites, they should be willing to shoulder more of the financial burden. McElroy spearheads an international group recently organized to explore the possibilities for foreign participation. "At our first meeting last November," he says, "a number of nations readily came forward with proposals to provide advanced instruments for the next generation of polar-orbiting satellites."

NOAA officials are also looking ahead to meshing their global monitoring efforts with NASA's space station program. In addition to a permanent manned station, this concept calls for "polar-orbiting platforms" that would carry a variety of instruments. The sensors now flying on weather satellites would be right at home on these platforms, says McElroy. Moreover, astronauts from a polar-orbiting space shuttle would be able to commute to the platforms via transfer vehicles to repair malfunctions.

The space station and polar-orbiting platforms are scheduled to be ready by 1992, in time for the five-hundredth anniversary of Columbus' voyage to America, but most observers expect this date to slip several years. If all goes as hoped, observation of the earth's environment from space—an effort that began just 25 years ago—will take another bold step. McElroy says he is excited: "The peaceful daily observation of the earth's atmosphere, oceans, and land from a polar platform—provided through international cooperation and tended by a multinational crew of astronauts—is one of the dreams of the space age." □

To cut procurement costs, Israel adds new components to 30-year-old tanks, fighters, and other weapons. The success of these weapons against advanced Soviet-made counterparts suggests lessons for the U.S. military.

Recycled Weapons

BY GERALD M. STEINBERG

THE massive costs and cost overruns, reliability problems, and rapid obsolescence that have plagued new military technologies in the United States are well known. This situation is exacerbated by a military-industrial "culture of procurement" (a term coined by James Fallows in *National Defense*) emphasizing flashy new weapons systems. Military officers advance their careers by managing big-budget programs such as the MX missile and the B-1 bomber. And weapons manufacturers have opportunities to increase their profits by designing everything from scratch in-house, whether a computer chip or a flashlight.

Other countries are far from immune to similar problems. Third World nations that face an army supplied by the United States, the Soviet Union, or Western European countries are forced to acquire the latest available military hardware. However, to lower costs, a number of countries have been extending the lifetimes of existing weapons by adding improved components, sometimes to older U.S. systems. For example, Malaysia, Indonesia, and Singapore have acquired refurbished A-4 Skyhawk assault aircraft orginally designed 30 years ago. France has developed "up-

Israel's military fitted old vehicles such as this French AMX-13 tank chassis with new light-artillery rockets—and sent them into war.

PHOTOS: ISRAEL MILITARY INDUSTRIES

The new Merkava tank (right) incorporates standard components such as a U.S. Teledyne Continental engine. However, it also has many special features, including a low profile and an automatic fire-extinguishing system to protect the crew.

Israel develops many new technologies for weapons components. Opposite: "Blazer" armor, which explodes outward if hit by a shell, can be added to existing tanks. An electrochemical process restores old ammunition and retards further corrosion. A shell for aging 90-millimeter guns has stabilizing fins and a high-energy core to pierce modern tank armor.

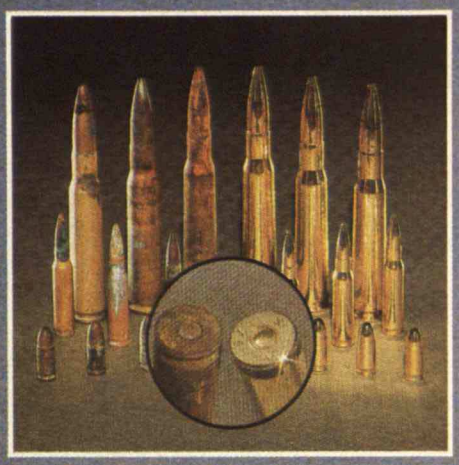
grade packages" for foreign owners of its Mirage 3 fighter-bombers, adding new engines, electronics, and missiles.

Sometimes the improvements in old weapons are so thorough that they result in essentially new systems. In fact, most Soviet weapons, including MIG combat aircraft and main battle tanks such as the T-62, T-72, and T-80, were developed this way.

Historically, the U.S. military used this process of refurbishing and upgrading quite extensively. Previous generations of tanks—beginning in the 1950s with the M-47 and extending to the M-60A3 that is still deployed today—were developed through a continuous process of upgrading and retrofitting. The F-4 Phantom fighter and B-52 bomber, both products of the 1950s, spawned many upgraded versions. Even now, though generally emphasizing new systems, the U.S. military continues to retrofit some weapons. The army and navy have begun upgrading some helicopters, and the navy has begun to renovate over 100 battleships that had been out of service since World War II. These ships are being outfitted with new electronics and defensive weapons, as well as new offensive systems such as cruise missiles.

Of all nations, Israel has the most extensive programs for upgrading weapons and retrofitting new technology into existing systems. In fact, almost every Israeli weapon, both imported and locally produced, incorporates something of this approach. Of the 3,600 main battle tanks fielded by the Israeli Defense Forces (IDF), over half are 30 years old, and some are significantly older. The force includes 1,000 British Centurions developed in 1945, 600 U.S. M-48 Pattons of Korean War vintage, and an equal number of old captured Soviet T-54/55 and T-62 tanks. It would seem that these antiques, even when

PHOTOS: I.M.I., RAFAEL, LIMAT



bolstered by some middle-aged American M-60s and a handful of new Israeli-made Merkavas, would be overwhelmed by the thousands of new Soviet T-72 tanks in the Arab forces. Yet this is far from the case.

In the air, the situation is similar. Half of the combat aircraft of the Israeli Air Force (IAF) are 15 to 20 years old, including U.S.-made Phantoms and Skyhawks, as well as a few French Mirage-3s. For transports, the IAF still uses DC-3s, first flown in the 1930s, and its main trainers are Fouga Magisters, designed for the French Air Force almost 30 years ago.

Perhaps what most separates Israel's recycled arsenal from that of other nations is the extent to which it has been tested in war against some of the most sophisticated Soviet weapons. Of course, war is not a controlled experiment: no one factor can be singled out as decisive in success. For example, in the 1982 Lebanon war, Israel fielded a combination of new U.S.-made F-15s and F-16s, refurbished older planes, and Israeli-made Kfirs—aircraft in which an American jet engine is mated to a French airframe. Electronic command and communication systems were crucial to Israeli success, as was the caliber of the pilots. However, in 1982 Israel did shoot down over 80 Soviet-made Syrian planes without losing any of its own. Upgraded and renovated weapons proved their worth.

Maintenance and Repair

In the United States, the operations and maintenance (O&M) allocation in the defense budget has been consistently sacrificed in favor of new weapons systems. A serious problem for the past 20 years or more, this imbalance is often decried by congres-

PHOTOS COURTESY OF IDF SPOKESMAN AND CONSULATE GENERAL (BOSTON)

Upgrading Weapons in the Third World

BY ANDREW L. ROSS

In 1976, the United States denied a request from South Korea to purchase the then-premier American battle tank, the M-60A1. The South Koreans decided to build on their experience in tank repair and upgrade their old M-48s—the main U.S. battle tank during the 1950s. Hyundai Heavy Industries, one of the largest of South Korea's more than 90 defense contractors, stripped the tank down to its hull and completely rebuilt it, adding an improved fire-control system, a new Korean-built diesel engine, and a 105-millimeter gun. The upgrading program, which continued until 1983, produced 567 tanks equivalent to the M-60A1.

This program is only one example of a growing trend. Military hardware sold on the international market today is extremely expensive. Leading producers such as the United States, France, Britain, and West Germany design most weapons with the European theater in mind. Many of these, such as the U.S.-made F-16 fighter, are highly complex and inappropriate for the needs of most Third World countries.

To keep up with technological advances and yet obtain low-cost, serviceable equipment, more than two dozen Third World countries have initiated weapons-manufacturing programs. An increasing number of these countries modify and upgrade older foreign-designed weapons. Following the example of the Soviet Union, which continually updates its MIG fighters and main battle tanks, many developing nations are incorporating breakthroughs into existing systems rather than seeking to produce or buy expensive all-new weapons.

Third World countries often start by modifying weapons to overcome specific problems, and then gradually begin to alter entire systems. India's upgrading of the British Gnat light fighter plane is a prime example of this process. Hindustan Aeronautics Limited (HAL), India's state-owned aircraft manufacturer, began building Gnats in 1959. While the fighter was relatively simple to produce, it was plagued with problems. The Gnat's unconventional hydraulic and flying-control systems cost the lives of many Indian pilots in test-flight crashes. In response, HAL extensively modified the lateral and longitudinal control systems and improved the hydraulic system.

This Indian-modified Gnat performed admirably against the Pakistani Air Force in the 1965 and 1971 wars. The diminutive fighter downed numerous American-built F-86 Sabres and slipped away from encounters with supersonic F-104 Starfighters. Before terminating production in 1974, HAL built over 200 updated Gnats for the IAF.

The Gnat did not simply fade away after rendering superior service. When it became obsolete, the little air-defense fighter continued to fly in a second incarnation as the Ajeet, a ground-attack aircraft. This transformation required more than 50 major modifications. HAL provided the Ajeet with "wet wings" (extra fuel tanks in the wing section), improved controls and avionics, and additional armament such as 500-pound bombs and 68-millimeter air-to-ground rockets. These modifications increased the Ajeet's range of action and improved its performance.

While an industrializing nation such as India may modify 200 Gnat fighters or 1,000 British Chieftain tanks, a country such as the Philippines, with a far less extensive technological infrastructure, refurbishes foreign weapons on a smaller scale. The Philippine Air Force (PAF) converted two U.S. C-47 cargo aircraft—the military version of the DC-3—into an airborne hospital and a gunship. The PAF also transformed an old American F-86D fighter into an executive transport plane.

Preventing Brain-Drain

In addition to giving developing nations access to advanced technology at lower costs, refurbishing weapons can provide much-needed ex-

port revenue. For example, South Korea's Daewoo Shipbuilding and Heavy Machinery Ltd. is rebuilding several hundred M-113 armored personnel carriers for the U.S. Army. In the early 1970s, Brazil replaced the original gasoline engine of the M-2 armored vehicle with a Brazilian Perkins diesel, and also installed a Mercedes-Benz diesel in the M-8 armored car. Brazil sold a number of these modified armored vehicles to Paraguay.

For many Third World countries, modifying foreign weapons represents a step toward making their own weapons. Brazil develops domestic models of foreign military hardware, manufacturing some foreign-designed components and designing other components from scratch. For instance, Bernardini, a private Brazilian firm, collaborated with the Directorate of Research and Technical Education (DRTE) in rebuilding some 80 American M-3A1 Stuart light tanks. The Brazilians replaced the Stuart's gasoline engine with a more powerful, domestically built Saab diesel. They installed new Brazilian-designed armor and tracks, as well as a turret designed and produced by Bernardini and a French 90-millimeter gun to boost the tank's firepower. The company also added new suspension and steering systems, and later incorporated a new front armor plate, a turbocharged diesel, and a Brazilian 90-millimeter gun.

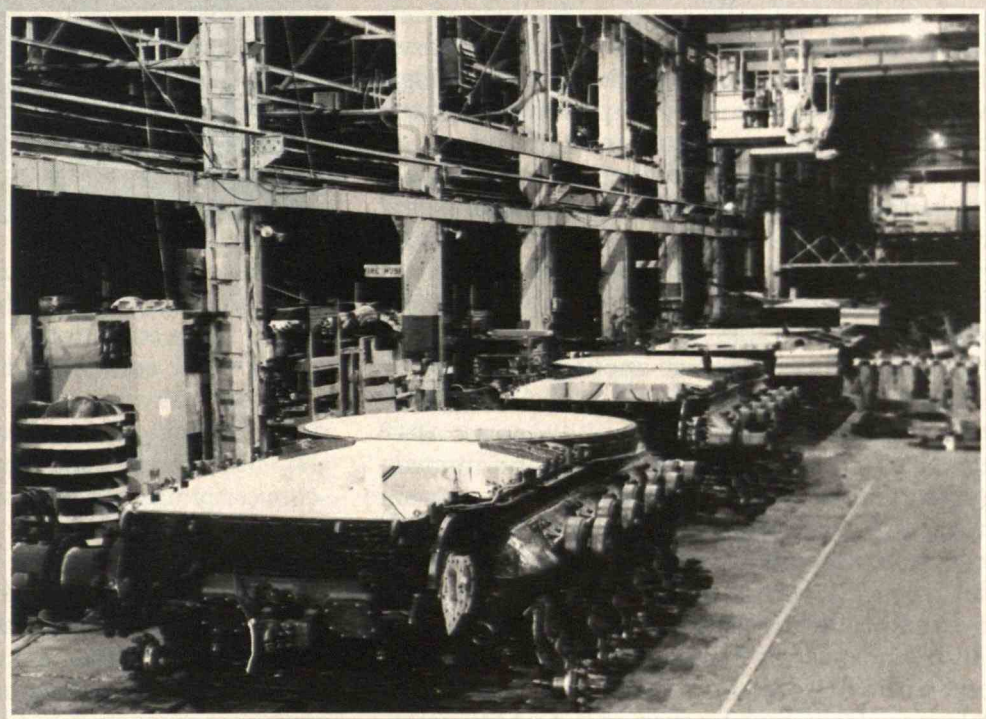
Upgrading weapons also helps developing nations prevent "brain-drain," by providing domestic opportunities for highly skilled technicians, engineers, and scientists who would otherwise seek employment in the First World. During the late 1970s and early 1980s, South Korea's Agency for Defense Development actively sought engineers for its naval, aircraft, armored vehicle, and missile projects. Offering unique defense R&D challenges, the agency successfully recruited South Koreans studying or working in the United States.

Third World arms producers often turn to dual-use technology that can serve both military and nonmilitary purposes. American, West German, and Swedish truck diesels power Brazil's upgraded versions of foreign-designed armored vehicles. Brazil's domestically designed armored vehicles use automotive components extensively. South Korea—the world's second-largest shipbuilder—uses the same technology in modifying foreign naval vessels as it does in building its commercial ships.

Occasionally, even the brand-new products of Third World defense industries are dual-use. Brazil operates the domestically designed Bandeirante aircraft for commercial purposes as well as for maritime reconnaissance and military transport. The West German BO-105 helicopter built by the Philippine Aerospace Development Corp. also serves dual purposes.

Upgrading is clearly an effective strategy for developing countries. The United States and its allies would do well to catch up with the Third World in institutionalizing such a process. □

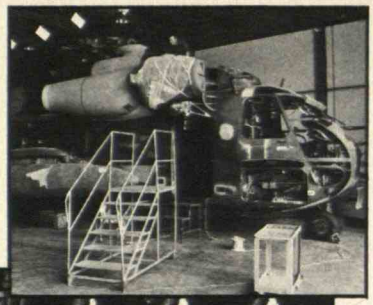
ANDREW L. ROSS teaches international security affairs in the Political Science Department of Vassar College. He is currently completing a book on Third World arms industries.



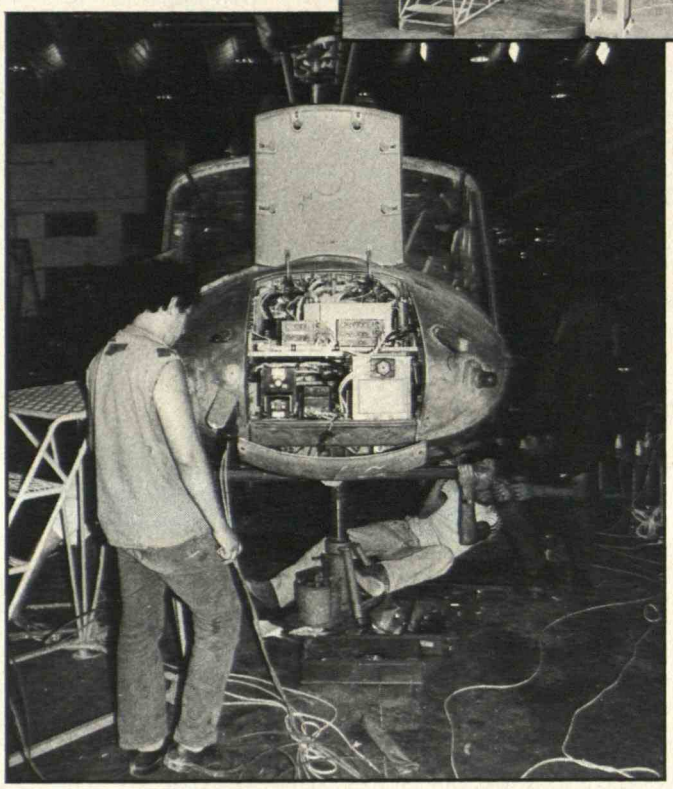
Opposite: Grumman is upgrading A-4 Skyhawks, first used by the United States in the 1950s, for Malaysia. The engines will be refurbished, extra storage for arms and fuel provided, and avionics updated.

Above: BMY, a company in York, Pa., upgrades M48s, the main U.S. battle tank in the 1950s, for nations around the world.

PHOTOS: GRUMMAN CORP., BMY CO.



Cyclone Aviation Products, an Israeli company, uses parts recycled from wrecks, and sometimes makes new parts, to repair or modify aircraft. Here workers are updating U.S. Bell and Sikorsky helicopters.



sional committees and Department of Defense (DOD) task forces. In 1980 a readiness check of aircraft by the DOD revealed that 44 percent of the air force's new F-15 fighters, which cost $25 million each, were not "mission capable" at any given time. Technicians are in short supply, and those that are available are often underqualified, actually damaging the aircraft during maintenance procedures. As a 1984 report by the U.S. General Accounting Office noted, "Progress made in force structure, modernization, and personnel readiness areas is not matched by progress in other readiness areas—namely equipment condition."

The Reagan administration has acknowledged the problem but has not remedied it. The 1985 defense budget includes $80 billion for O&M, a 10 percent increase over the previous year. However, this is $2.2 billion less than originally proposed because of cuts by both the administration and Congress. Meanwhile, funds for procuring glamorous big-budget items have increased by over 17 percent. The O&M problem is actually growing worse.

In Israel, refurbishing and upgrading weapons—and even designing new systems—are processes that begin in maintenance and repair. Israel's armed forces often assign their best technicians and officers to O&M; as a result, the "downtime" when major weapons are inoperable is far lower than in the United States. This advantage applies even to weapons used by both countries, such as F-15 and F-16 fighters and M-60 tanks. Israel's weapons are often repaired during operations or battles and immediately returned to service. Proper maintenance not only increases the readiness of weapons but extends their lifetime and lowers costs over the long term.

This focus on maintenance originally resulted from Israel's difficulties in importing weapons. Before independence in 1948, the British prevented the Haganah, the defense arm of the Jewish community in Palestine, from buying even rudimentary weapons. Meanwhile, Arab groups easily smuggled guns and ammunition from neighboring countries. Thus, the Haganah handled any weapons it obtained with great care. The group smuggled in parts piece by piece and reassembled them. It also manufactured ammunition and grenades from recycled aluminum, including parts of a British plane that had crashed in the desert.

The equipment problem became critical during the 1948 War of Independence, when every scrap of weapons material was recycled. The Israelis shot down an Arab Spitfire in the Mediterranean, dredged it out, and reconditioned it for combat. The rest of the air force consisted of obsolete aircraft shipped from the junkyards of World War II surplus equipment, including P-51 Mustang fighters, B-17 bombers, and Czech-made copies of German Messerschmitt fighters. The main task of the Israeli ground crew (as well as the pilots) was to keep these museum pieces in the air.

The armored forces and navy faced the same problems, scouring the junkyards of Europe for surplus Sherman tank bodies and treads to ship to Israel and reassemble. Mechanics made missing components and spare parts by hand. The army also salvaged a few obsolete tanks that the British had ditched in the Carmel Mountains before withdrawing from Palestine. The navy managed to acquire a few old hulls and World War I-vintage Italian naval guns, which it refurbished and sent into service.

After independence Israel became more systematic about maintaining and repairing its weapons. The military services, along with the major government-owned defense manufacturers and technological centers, focused on developing and applying advanced

PHOTOS: NIV VIGDOR; BAMAHANE

Upgraded weapons proved their worth: Israel shot down over 80 Soviet-made planes without losing 1 of its own.

maintenance and repair technologies. For example, turbine blades, which spin at 14,000 revolutions per minute at temperatures over 2,000°F, suffer from "creep"—a gradual deformation. Israel Aircraft Industries (IAI), a large government-owned company, developed metallurgical heat treatments to reduce creep and extend the blades' lifetime. Another example: each engine used in the A-4 Skyhawk contains 48 fuel-nozzle rings that wear out rapidly and must be replaced, or they will cause further damage. IAI developed high-temperature-resistant components welded on with electron beams that last much longer than these rings. Pratt and Whitney has incorporated many of these techniques, as well as new metallic, plastic, and composite materials developed by Israel, into some of the engines it manufactures in the United States.

At the opposite end of the cost scale from fighter jets, a technique has been developed by Israel for recovering corroded ammunition. Bullets and shells carried in battles and maneuvers or stored for extended periods are often unusable. Israeli technicians devised an electrochemical polishing process that cleans ammunition, polishes the brass casing, and treats the surface to retard corrosion. Though lacking in glamor, this process has saved the IDF tens of millions of dollars.

New Technologies for Old Weapons

Building on its vigilant maintenance programs, the IDF has continually upgraded and retrofitted aging weapons. This has kept them at or close to the state of the art at a fraction of the cost of developing and building new systems.

Government-owned firms such as IAI, the army's Ordnance Factory, and the National Weapons Development Authority (known as Rafael) began upgrading older weapons during the 1960s. World War II-vintage Sherman tanks received new guns and engines to become "super-Shermans." To transport weapons, IAI purchased and modified surplus Boeing Stratocruisers, used by the U.S. military throughout the fifties, adding swing tails that allow bulkier payloads to be put aboard the planes.

Prior to the Six-Day War with Egypt in 1967, IAI transformed the Fouga Magister, built under a French license, from a trainer to an attack and ground-support aircraft. The company introduced plastic airframe components, including the tail cone and canopy frame, to lighten the load, and added a radio compass to improve navigation. Both features were innovations for military aircraft. Israeli engineers also markedly improved the performance of the French Mirage 3 combat aircraft by adding new components, including avionics (the electronics in military aircraft). France incorporated these Israeli additions in its Mirage 5. Finally, the IAI converted a number of old Boeing 707 passenger jets, purchased from TWA, into refueling planes equivalent to U.S. KC-135 tankers.

Today the IDF continues to use aging A-4 Skyhawks and F-4 Phantoms retrofitted with state-of-the-art electronics and avionics. One addition, the MAHAT computerized weapons-delivery system, greatly increases pilots' ability to guide air-to-air and air-to-ground missiles but does not divert pilots' attention from defending themselves. Even the relatively new F-16s are to be improved through such technologies as "look-down, shoot-down" radar, which focuses on moving targets such as aircraft and tanks and filters out background clutter.

Israeli skills in combining maintenance with upgrading are also illustrated by the armored corps. Although they are 30 to 40 years old, U.S. M-48 and British Centurion tanks are still solid, durable platforms for new systems. The Israelis have equipped the M-48s with new diesel engines, larger 105-millimeter guns, new armor, computers, laser rangefinders, and night-vision infrared systems. With these additions, the "obsolete" M-48 is superior to the newer U.S. M-60, and in many respects it is equivalent to the improved M-60A3 still used by the U.S. Army. However, the Israeli tank was far less expensive to obtain.

Israel has similarly upgraded captured Soviet tanks, rocket launchers, and other weapons. In 1967 Israel captured a number of Soviet T-54/55 tanks dating from the 1950s. Although very sturdy, they were outdated, uncomfortable for the crew, and vulnerable to fires when hit. The IDF turned them into front-line weapons by reconfiguring the crew quarters and installing the same diesel engines, guns, and electronics used on the Israeli-modified M-48s, M-60s, and Centurions. Only the original shell and treads, the soundest parts of the Soviet tank, were left intact.

Israel has also not been averse to "reverse engineering" of Soviet weapons, particularly when they are superior to available Western equipment. After

the Israelis captured Soviet Katushya rocket launchers, the government-owned Israel Military Industries (IMI) developed a similar system that can launch ten rockets in four seconds. The launchers are mounted on the chassis of the oldest Sherman and Centurion tanks—in Israel, nothing is thrown away.

New Weapons with Off-the-Shelf Parts

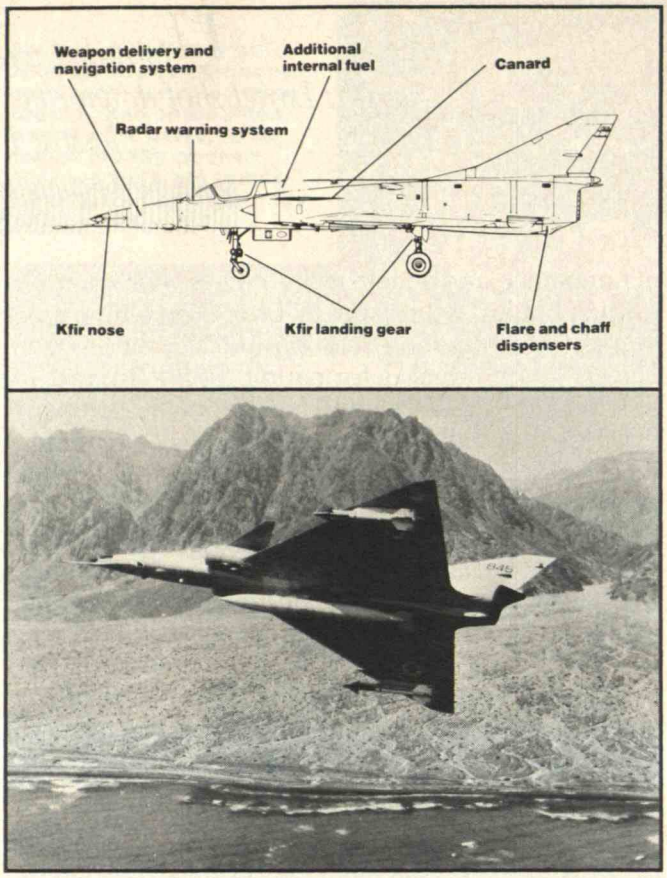
The Israeli military has also begun producing its own advanced weapons. But in these programs, too, Israeli engineers—seeking utility in battle, ease of maintenance, and low cost—prefer to combine proven technologies rather than invent entirely new ones, particularly for major weapons systems such as tanks, aircraft, and ships. This approach, a marked contrast to that used by many Western powers, limits development costs, time, and uncertainty. By using available technologies, Israel takes an average of 5 to 6 years to design and deploy a weapon system, while the United States typically requires 10 to 12 years.

Israel first began to design and produce weapons over 35 years ago. During the War of Independence, when Israel found itself without response to Arab artillery, the "Science Corps" hollowed out axles from locomotives to make launching tubes. Technicians then filled sections of irrigation pipe with homemade explosives for shells. The main result was a lot of noise, but the "Davidka" convinced the enemy that major attacks were underway.

Design and production of weapons accelerated after the 1967 war, when the French suddenly changed sides in the Arab-Israeli dispute and embargoed shipment of all weapons to Israel, including the Mirage 5 fighter-bomber. Israel promptly set about making its own combat aircraft.

Rather than start from scratch, the IAI applied a component-based design philosophy. Israel first produced the Nesher, an improved version of the Mirage 3 equivalent to a Mirage 5, but the IAI sought further improvements. By 1969 the United States had begun selling Israel F-4 Phantoms powered by General Electric J-79 engines, which allowed greater range, speed, and payload than other aircraft had. As IAI gained experience, it decided to mate the French Mirage airframe with the American engine. The first flight was a dangerous affair: the plane overheated and almost crashed. But IAI engineers solved the problem and produced the Kfir, or "lion cub."

This aircraft is not likely to set any speed records



In developing the Kfir (bottom), Israel mated the French Mirage airframe with a General Electric J-79 engine. Now that the Kfir has been successful in combat, Israel sells superior components designed for this aircraft to other nations that own Mirage fighters (top).

or win beauty contests, but it has proven its worth against Soviet-equipped forces in both the 1973 Yom Kippur War and the 1982 Lebanese conflict. While perhaps most useful for ground support, the Kfir can be used in air combat. Later models incorporated improvements in the engine that provided more payload capacity and range. The Kfir also has advanced Israeli avionics such as the Elbit System 82 computer. This allows the pilot to deliver air-to-air and air-to-ground missiles more accurately and thereby hit newer, faster enemy planes.

The Kfir's success has crystallized the Israeli design philosophy of integrating advanced components into proven weapons. While R&D costs for U.S. aircraft reach billions of dollars, the Kfir was developed for about $250 million.

The same design philosophy is embodied in an indigenously developed tank, the Merkava, which entered service in 1979. Like the Kfir, it incorporates an American engine. In fact, the Teledyne Continental engines used in Merkavas are standard in upgraded Israeli M-48s, M-60s, and Centurion tanks: in the 1982 war, tank maintenance crews had to carry spare parts for only one type of engine. But the Merkava also incorporates a number of Israeli

PHOTO: ISRAEL AIRCRAFT INDUSTRIES

Israel typically takes 5 to 6 years to deploy a weapon system; the United States requires 10 to 12.

innovations. Its armor-piercing shells have fins to keep them on track in their flight toward distant targets. More energy is imparted to their small penetrating cores than to standard shells, and the computerized firing-control system increases the probability that an enemy tank will be destroyed on the first shot. In the 1982 war Merkavas destroyed tanks 3.5 kilometers away and pierced the armor of advanced Soviet T-72s.

The IAI made an apparent departure from this component-based approach a few years ago, when Israeli engineers began work on the Lavi combat aircraft, which has a wholly new airframe. But though critics have expressed concern about the $1.5 billion R&D cost for this plane, Israel's development philosophy has remained fundamentally unchanged. The IAI has contracted with Pratt and Whitney for the engine—the PW 1120, to be based on the F100 engine that powers the F-15. In fact, many parts of the new engine are interchangeable with the old. IAI designed the composite-material wing and tail assemblies in cooperation with Grumman Aircraft, which will manufacture the first 50 units. The first test flights are scheduled for 1986, with deployment to begin three years later.

Even in developing a weapon from scratch, the IDF generally follows the component-based approach. One example is the design of mini-RPVs (remotely piloted vehicles)—surveillance aircraft that Israel was the first to use extensively in battle. These unpiloted planes have television cameras and electronic ferret devices that transmit information to command centers, giving a clear picture of the battle and target locations. RPVs are inexpensive compared with reconnaissance aircraft, and, of course, there is no pilot to worry about. The Israelis used readily available technology and off-the-shelf components to produce these aircraft.

When Israel does develop a truly new technology, it is in the form of components. For example, the country has been able to modernize its tank fleet inexpensively by developing new "Blazer" tank armor that deflects small bullets and explodes outward when hit by shells and rockets.

The surprises and failures endemic to U.S. arms development stem partly from the American emphasis on all-new systems, but also from a related problem—unrealistic testing procedures. Evaluators have little contact with the individuals who will actually use a weapon. And often the manufacturer itself or military personnel with an interest in promoting the technology perform the tests. As a result, faults are not revealed until late in the development process.

For example, the U.S. Army's new Patriot ground-to-air guided missile passed its tests at White Sands Missile Range with flying colors. Only later did the army discover that cable connections proved fragile during actual operations, and that soldiers found the Patriot too difficult to use. Another example: it was clear from the start that the RH-53 Sea Stallion helicopters employed in the abortive effort to rescue U.S. hostages in Iran might be used in the Persian Gulf. Yet they were not tested in desert conditions, and the air filters on their engines proved inadequate.

In Israel, preliminary versions of new weapons are rigorously tested by the military—including soldiers who may actually use them. Individual designers and producers often use the weapons during their annual 90-day reserve duty: the engineers' personal safety may depend on their having done their jobs well. The weapons may also be tested in combat.

In accordance with this "fly-before-you-buy" policy, three or four models of the Kfir were developed and flown by military pilots before it was considered ready for production. Also, the first models of the Shafrir air-to-air missile proved ineffective in tests during the 1967 war. Only after the problems were solved and the missile was successfully tested in 1969, during the War of Attrition, did the Shafrir 2 go into full production.

The component-based approach to design may make it easier to effect changes in response to tests. The Merkava was designed in a modular fashion to allow easy upgrading, and changes were indeed required after the IDF's ground forces tested the early model, the Mark I. The production model, designated Mark II, has a larger engine and an improved gear box. Although rigorous testing may lengthen the R&D process, it yields weapons that are ready when needed in battle.

Lessons from the Israeli Experience

Of course, comparing Israeli and U.S. weapons development is difficult. With global interests, including defending Europe and maintaining the nuclear balance, the United States plays in another league. It plans to produce such strategic weapons systems as the MX missile, the B-1 bomber, and a space-based ballistic-missile defense. While Israel produces half of the weapons it needs, the other half comes from

The engineers' personal safety may well depend on their having done their jobs well.

the United States, including helicopters, much of its advanced electronics and avionics, early-warning and battle-management aircraft, and, of course, jet and diesel engines for aircraft and tanks. Israeli industry does not even attempt to produce thousands of components that the military needs. That Israel is able to focus its R&D effort more sharply than the United States should come as no surprise.

The differences between the two countries' international situations affect their development of weapons. The IDF is able to test new weapons in battle, whereas the U.S. military rarely can—indeed, it often relies on Israeli experience with American arms.

The Israeli and U.S. governments also differ in fundamental ways that would be difficult to change. The U.S. military budget is subject to legislators' "pork-barrel" efforts to bring defense contracts for advanced-technology weapons to their districts or states. In Israel the defense industry does form a formidable lobby, but it has less impact than its U.S. counterpart on military production. In particular, the pork-barrel factor is limited: members of the Knesset, Israel's parliament, are elected nationwide, not from local districts.

Other institutional factors within each country's military-industrial complex may be deep-rooted but deserve scrutiny. Most Israeli weapons manufacturers are government-owned and have a mandate to further national security. However, most U.S. military contractors are private, and for them new technology means large profits. For the Pentagon brass, new technology means large budgets, perks, and promotions. Although the B-52 bomber may still be perfectly adequate for its mission more than 30 years after initial production, the U.S. Air Force and aerospace contractors have been attempting to push through a replacement for two decades—first the B-70 and more recently the B-1. The B-1 is now entering production even though the Carter administration believed, and many military analysts continue to be convinced, that it will be vulnerable to Soviet air defenses soon after it is deployed.

The U.S. military is a large, hierarchical organization. As former Secretary of Defense James Schlesinger has noted, such a structure tends to be a "remarkably efficient mechanism for the suppression of new ideas and alternatives." The Israeli military has a more fluid organizational structure: low-level units and even individuals often take the initiative in proposing improvements in weapons. The U.S. armed forces could try to emulate such flexibility and encourage closer links between designers and weapons users in the lower ranks.

The U.S. Congress has attempted to shift responsibility for testing and evaluating new weapons away from their manufacturers and military sponsors. Last year, over the objections of the military, Congress created an independent test and evaluation agency. However, the Pentagon has refused to appoint a director, and the new organization has failed to get off the ground.

The United States should make other institutional changes to improve repair and maintenance. Greater emphasis on these operations would not only enhance national defense but might lead to opportunities for upgrading weapons and designing new ones that incorporate existing components. In Israel, the same crews at IAI's Bedek Division that maintain and repair aircraft engines have devised the new technologies to lower service costs and improve performance. By developing the various tank-upgrade packages, the Army's Ordnance Division was instrumental in designing the Merkava.

Several countries have purchased Israeli weapons and weapons-upgrade services. The Swiss Army, for example, has contracted with Israel to upgrade its British-made Centurion tanks, and the IAI upgraded Indonesia's U.S.-made A-4 Skyhawks. In fact, IAI's Bedek Division has recently contracted to service U.S. helicopters in Europe, and Israel has provided the United States with information on a number of its weapons-upgrade packages, such as the Blazer tank armor. These first steps suggest that the U.S. military might benefit from further cooperation with Israel on maintaining, upgrading, and designing weapons. In the long run, the United States should learn to apply recycling technologies more systematically to its own weapons systems.

GERALD M. STEINBERG teaches science and public policy at the Hebrew University in Jerusalem. Formerly a research fellow at M.I.T.'s Center for International Studies, he is the author of Satellite Reconnaissance *(Praeger, 1983) and numerous articles on the Israeli military industry.*

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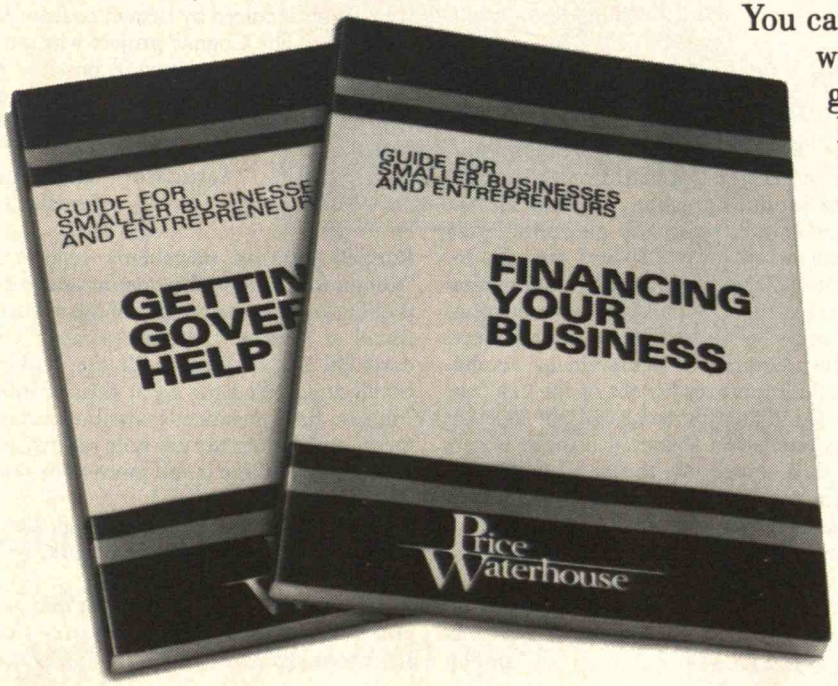

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Continued from page 9

to take their land out of production completely. As a result, money spent for soil conservation would go farther than it does now.

The study by the American Farmland Trust gives high marks to this proposal, especially since technical advances in measuring soil performance now allow analysts to target problem areas more precisely. For example, in 1977, the Agriculture Department completed the first-ever inventory of millions of soil samples and entered the findings into a computerized database. This, in turn, has yielded crude estimates of how much soil loss various types of terrain can tolerate under a variety of conditions without losing productivity. Jack Doyle of the Environmental Policy Institute, a Washington-based research and lobbying group, predicts that applying the proposed land-reserve strategy to just 12.5 million of our most erodible acres would save 600 million tons of soil a year. This is roughly a third of all the soil now being lost.

But Congress may not go for the idea. The House passed such a measure last year, but it bogged down in the Republican-controlled Senate. Opponents feared that it would take too long for savings to be realized from the program. Obviously, an impasse of this kind could recur this year.

This kind of shortsightedness has prevailed for too long, allowing soil-conservation and other farm programs to go their separate, contradictory ways. While fewer than 3 percent of Americans now live on farms—down from one in four as recently as the 1950s—all of us, as well as future generations, have a stake in keeping farming a viable occupation. We cannot afford to perpetuate policies destructive to the integrity of the land. Egypt, Iran, and Iraq are just three of the nations whose early civilizations sealed their fate by squandering their topsoil. There is no reason to suppose that it couldn't happen here. □

Continued from page 3

diction to oil, not to increase it. But instead, funds for conservation and other alternative energy programs have been slashed, and oil exploration is being pursued as if it were a real solution. It is not.

Francis de Winter
Santa Cruz, Calif.

Mr. de Winter is president of Atlas Corp.

Henry Petroski predicted that the radical Hutton Tension Leg Platform (TLP) would begin producing oil in October of that year. He was right: the platform began producing oil only 22 days after its installation. This was the fastest completion (from platform installation to production) of a major offshore development project.

This remarkable achievement emphasizes an important benefit of the TLP concept. As a floating structure, the TLP can be assembled in sheltered inshore waters and then towed out to the oil field. This minimizes the need for major assembly operations in exposed offshore conditions. Even if inshore assembly time is added to the 22-day installation process, the TLP concept still saves time and money.

George L. Edwards
London

George L. Edwards is manager of public affairs for Conoco (U.K.) Ltd.

Henry Petroski states that the Cognac platform now holds the deepwater record: 1,025 feet. He also says that this platform was "manufactured by Brown & Root for Shell Oil." The Cognac project was a tremendous achievement made possible by the skilled architects, engineers, and craftspeople at McDermott Marine Construction.

Francisco J. San Miguel
Amelia, La.

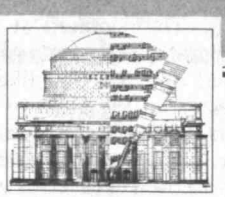
Randall Johnson mistakenly reports in "Oil on Ice" *(August/September, page 44)* that Exxon was the builder of the artificial island at Mukluk, Alaska. In fact, Standard Oil Co. of Ohio built the Mukluk island and drilled for oil at this location. Johnson also mistakenly attributes statements concerning the dry hole results, and the fact that "there is still more to be done up there," to Exxon.

George H. Lewis
New York, N.Y.

Mr. San Miguel is vice-president and general manager at McDermott Marine Construction, and Mr. Lewis is senior advisor

MIT
APRIL 1985

100 YEARS OF MUSIC AT M.I.T.



The white rabbit played a trumpet. At the feet of the piccolo player, who wore a ruffled pinafore, was carefully placed a small and well-scruffed teddy bear. On top of a French horn player's head was a three-foot-wide plastic lobster. One player grasped a white tuba against his tuxedo jacket, which covered • • •

MIT
APRIL 1985

100 YEARS OF MUSIC A4
THE WHITEHEAD DEDICATION A14
Celebrating the consummation of an unprecedented partnership
WHERE HACKING BEGAN TO PAY OFF A15
The Tech Nickel Plate Railroad
ENTERPRISE FORUM A18
Alumni united by entrepreneurship from Boston to Seattle
UNDER THE DOMES A14
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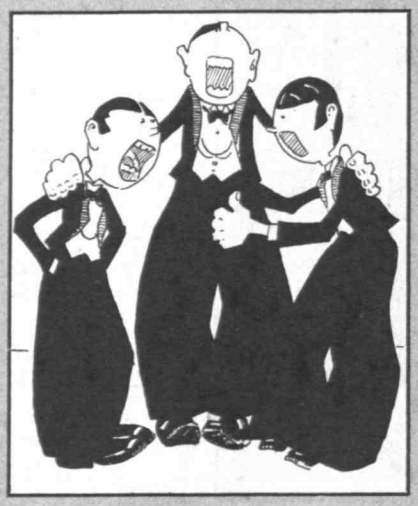


ABOUT THE COVER

The popularity of vocal groups at M.I.T., reflected in the above artwork from the 1928* Technique, *dates back to the founding of the Glee Club in 1884.* Technology Review *celebrates the beginning of the second century of music here with a colorful personal essay by noted arts writer China Altman, from which the cover paragraph is taken.

STUDENT VIEW

DIANA BEN-AARON

The Unflappable Engineer Revisited

Last term, I had a wonderful idea for a *Tech* photo. I was going to take a picture of the last meeting of 2.70, the famous mechanical engineering design course. I already knew how the last class would have to end. Woodie Flowers would write "CONTEST NEXT WEEK—GOOD LUCK" on one of the blackboards in his large clear draftsman's capitals, press a button to send the board skyward, the class would spring to its feet and applaud, Woodie would bow, and I would capture all that overflowing teacher-student rapport in a wide-angle lens for the front page.

It didn't happen that way, and not just because the professor who gave the last lecture wasn't Woodie. The fact that the professor was using an overhead projector instead of a blackboard wasn't what ruined the photo either. The problem was that he was determined to tell, in the last ten minutes of the course, about every type of widget ever invented. No one seemed to be listening—after all, only 100 hours were left until the contest, and the students' machines were far from finished—but the professor was firm in his resolution not to send them out into the world ignorant.

At ten minutes to one, the room grew restless. At five minutes to one, the bell for the end of the period rang and the students closed their notebooks and put away their pencils. They cleared their throats. They looked at the clock and half-rose from their seats. Still he pressed on: "I'd just like to say a few words about the class of angle-beveled ratchet pivot widgets, which you'll often see in . . ." At one o'clock, he finally wound down. The class gathered up its half-built Heath Robinson contraptions and bolted back to the machine shop, muttering imprecations about angle-beveled ratchet pivot widgets. No applause. No teacher-student rapport. Just a professor gathering up his transparencies and wondering why the students weren't as eager as they used to be.

Of course the faculty wants to pour as much specialized knowledge as they can into us before we leave. Companies want specialized engineers—people they can drop into slots without additional training. Teaching us skills in demand is a worthy aim. But it might be more realistic to try to convince industry that it needs freshly minted graduates with a wide range of theoretical and mathematical tools (and skills acquired outside the classroom, such as working with and managing people) that can be applied to any problem—rather than experts in manufacturing processes that can be supplanted at any time by a new technology.

You Say You Want a Change of Pace?

Not that the theory courses are any less grueling. Take the introductory electronics course for electrical engineering and computer science majors, called 6.002. Now 6.002 is not a descriptive course; it is an equation-writing and solving course. The professors don't start by telling you what an op amp looks like and how it works and how it was invented and how it has improved your life; they just draw an op amp integrator circuit on the board and think out loud about the response r to a step impulse I at time t equals zero. Filling in the background is your problem.

President Gray taught a recitation section of 6.002 last spring. I am told he was appalled and overwhelmed by the amount of material crammed into the 14-week subject. I was heartened to hear it—I had done very badly in 6.002, unable to keep up with the paralyzingly rapid once-through tour of electronics from the electron to the digital double-transistor configuration. But my source for that nugget of information, Marta, a junior in electrical engineering, said she had found 6.002 easy: "It made sense."

DIANA BEN-AARON, IMMEDIATE PAST EDITOR-IN-CHIEF OF THE TECH, *PLANS A CAREER IN JOURNALISM WHEN SHE COMPLETES A DEGREE IN HUMANITIES AND MATERIALS SCIENCE THIS YEAR.*

The Institute is an ideal place for young wolverines to grow up.

Some people here get bored if their courses aren't hard enough. Professors have to teach the same subject to students of widely varied abilities. As mathematics professor Arthur Mattuck tells his algebra students, "For some of you, the first few weeks of this course will be totally new; and for others it is old hat. We are going to compromise. We're going to go very fast."

"M.I.T. is an ideal place for young wolverines to grow up," says Rene, a fourth year student. "It has a terrible atmosphere, but if you turned the workload down to a dull roar, everything else would follow."

I question his logic. The passion for proving oneself at the extremes of endurance, and making things artificially difficult to increase the prestige of the win, goes as deep in M.I.T. students as the "right stuff" did in Tom Wolfe's fighter-pilots-turned-astronauts.

Freshmen soon realize that upperclassmen are routinely "hanging their hides out over the edge" and "pushing the outside of the envelope." Upperclassmen reinforce the message that we regularly achieve the impossible. We hide false starts, mistakes, and failures (after all, we have to get up and go to lab tomorrow, and we can't afford to get depressed), leaving an unbroken and misleading record of success. We pretend to be Unflappable Engineers, implying and inferring that we can assemble and debug the tools of our trade blindfolded after six consecutive all-nighters—whereas we are really just as confused as the next student.

A few idioms and translations from the Unflappable Engineer's phrasebook:

☐ *"You're on Pass/Fail. What are you worrying about?"*
Of course, I got all A's my freshman year.

☐ *"Don't overload."*
I'm triple majoring, but that doesn't mean you can.

☐ *"You should get some sleep."*
I've been up for 60 hours, but you should really get some sleep.

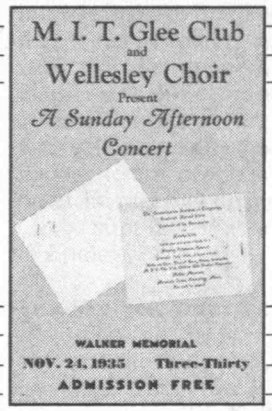
"If you complain about the pressure to your professors, they say, 'We know what's causing the pressure and we can sum it up in three words: Independent Activities Period (IAP),' " according to Trish, who graduated last year and is now studying at the Harvard Graduate School of Education. "They say if each term were two weeks longer, the pressure would disappear. But if they had those two extra weeks, they'd probably just come up with more stuff to teach." Dominic, a sophomore, agrees: "One of my professors last term used a review session for the final to teach new material." Even alumni who went to school year-round during the war tell me they hear the courses are harder now.

Students at other colleges took their books home over winter vacation to study for January finals. But we finish early to enjoy IAP, four weeks of unstructured time in an almost-full-service university environment. We're counting our blessings: the faculty can test our patience and endurance during the term if they must, but don't anyone try to tell us about angle-beveled ratchet pivot widgets while the calendar says January. Even Unflappable Engineers need a breather.

ILLUSTRATION: ELIZABETH SLOTE

100 YEARS OF MUSIC AT M.I.T.

BY CHINA ALTMAN



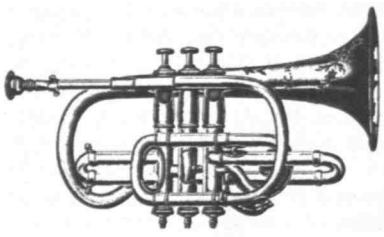
1884: *The Banjo and Glee Clubs are launched, and the Orchestra appears in the first of many incarnations.*

1890: *The Mandolin Club is formed; the Banjo Club revived.*

1910: *The first major combined tour of the Banjo, Mandolin and Glee Clubs.*

1922-1938: *William E. Weston coaches the Glee Club.*

The white rabbit played a trumpet. At the feet of the piccolo player, who wore a ruffled pinafore, was carefully placed a small and well-scruffed teddy bear. On top of a French horn player's head was a three-foot-wide plastic lobster. One player grasped a white tuba against his tuxedo jacket, which covered all but a couple of inches of his red bathing trunks. His legs were bare and he wore sneakers, no socks. Dracula played the oboe. A clarinet protruded strangely from the black drapes of an apparition, with two electric light bulbs—small, red and lighted—in the spot where eyes should be. One of the saxophones was played by a '30s-style siren.



The event was the 1984 Halloween performance of the M.I.T. Concert Band, 80 musicians arrayed in a semi-circle on the floor of M.I.T.'s main entry, Lobby 7. And the enchanting thing, strange and exotic as the costumes were, was the way their music sounded in the tall, domed space.

Facing the band across the worn red strip of carpet that bisects the lobby and connects the front door to the Infinite Corridor, an audience about three times the size of the band sat on the benches or the floor, some leaning against the walls and pillars. People leaned against the railings on two tiers of balconies, clustering between the long banners to to get a better view.

CHINA ALTMAN, former UPI correspondent in Boston, New York and Europe, also covered New England for *Life* and *People* magazines. Following many years of work in radio and TV, she joined the M.I.T. News Office, where she is successful in attracting national media attention to the arts on campus.

It was a long way from October of 1884. Then, several young men dressed themselves in tuxedoes, as befitting the seriousness of what they were about to do, and gave the first instrumental concert ever performed at the 23-year-old Massachusetts Institute of Technology. Their band consisted entirely of banjos, except for one flute played by a lad named Arthur D. Little.

I reflected on these two concerts, the one I saw below me from the third floor balcony on the last day of October, 1984, and the older one that had built itself in my mind from story shreds and phrases collected here and there since I came to M.I.T. two years ago to write about the arts.

"There's a really good story about music at M.I.T. and nobody has ever written it." That's the gist of something I've heard so many times that I came to see it as a challenge and a bugbear.

The really big story may not ever be written—since it is writing itself every-

1923: *The dance orchestra, the Techtonians, begins a popular tenure; the Choral Society makes its first, but brief, appearance.*

1925: *The combined Music Clubs make their first radio broadcast and give their first Christmas concert.*

(Top) The Choral Society performs in Heidelberg on its first European tour.

1926: *An era begins to fade—the first concert with no novelty acts is held.*

day—but I will try for an illusion of solid ground by looking at three things: an inventory, the prevailing myths, and some of the questions.

The inventory is the most straightforward. Starting at the center, M.I.T. has nine faculty members, an additional nine members of the teaching staff, and 14 affiliated artists. There are five faculty-led performance groups for which participation carries academic credit. There are nine other performing groups, an average of 75 concerts on campus every year, and 41 music classes that enrolled 800-900 students last year.

Still at the heart: the music library, among other things, developed such a fine and elegant project for collecting the work of contemporary composers that it was defined by several prominent scholars as a model for other cities to follow.

And not forgetting the Experimental Music Studio, securely bound as it is into that esoteric loop encompassing the three "big timers" of computer/experimental/electronic music: IRCAM, Stanford, and M.I.T. IRCAM is the Institut de Recherche et de Coordination Acoustique/Musique in Paris.

Then there's the Artificial Intelligence Lab, which acquired from Vienna this Feburary its own computer-modified Bosendorfer grand piano for research/performance endeavors and which occasionally produces concerts for the people in Technology Square Building Beta (also known as NE43).

The history of music here seems to divide into four eras.

First, 1884-1932: sporadic, happy and hopeful amateurism, with banjo, mandolin and glee clubs, minstrel and vaudeville shows, continual rebirth and fading-out of an orchestra.

Second, 1933-1946: The Glee Club and others present concerts of classical music with no sideshows or novelty acts.

Third, 1947-1972: The Klaus Liepmann years. Along with establishing music here as we know it today, the Institute's first full-time director of music connects the large outside world of music to M.I.T. by bringing great artists to perform, to visit and—some—to stay. At times 50 to 70 members of the Boston Symphony Orchestra join with M.I.T. groups for performances. Parallelling the growth of music in this era was the evolution of Course XXI, founded in 1955 and offering today three main options: a full humanities major and the humanities/engineering and the humanities/science options, with music as one of ten possible concentrations.

Fourth, 1973 to the present. Numbers of faculty, teaching staff, affiliated artists, programs, students, energy and spirit continue to take on new life.

Clarinet or Plasma Physics?

The recurring myths are these:

☐ People who are good at math-science-

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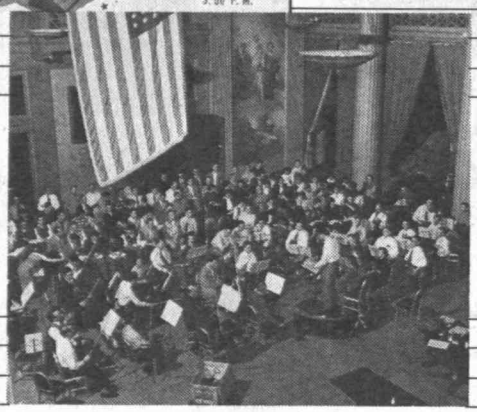


(Above) Klaus Liepmann.

1933: *The Little Symphony is organized.*

1946: *The Glee Club offers its first performance of the* Messiah.

1947: *A watershed year—Klaus Liepmann comes to the Institute as head of the music program and conductor of the Glee Club, the revived Symphony, and the Choral Society.*

(Above) Liepmann with Gregory Tucker

1948: *John Corley joins the music program as conductor of the Concert Band and the Brass Choir; a London Sting Quartet performance launches the professional concerts.*

engineering are good at music.

□ People who are good at those things have a greater need than others at least to hear music, even if they aren't making it themselves.

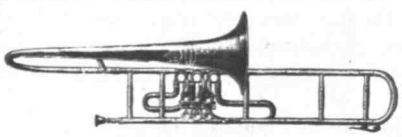
□ And a lot of those who chose scientific/engineering disciplines at M.I.T. would have done just as well if they had chosen music for their careers.

The myths lead to the questions:

First, are the myths true?

How is the experience of music at M.I.T. different from that at a professional music school? At a liberal arts school?

Can students with little or no background in music become turned-on to



music for life because they came here?

And does the music here "sound" different?

These were the kinds of questions going through my mind as I listened to the music of the Concert Band in Lobby 7. Though the inventive costumes were clearly a source of delight for the audience, there was something in the music that held us, and not just because of the unusual acoustics (Someone once figured a vibration rate of seven seconds for Lobby 7). Except for one piece, all this music had been written within the past couple of years, including two compositions by students. A music critic would have to appraise it, but there was no question that the audience was enticed.

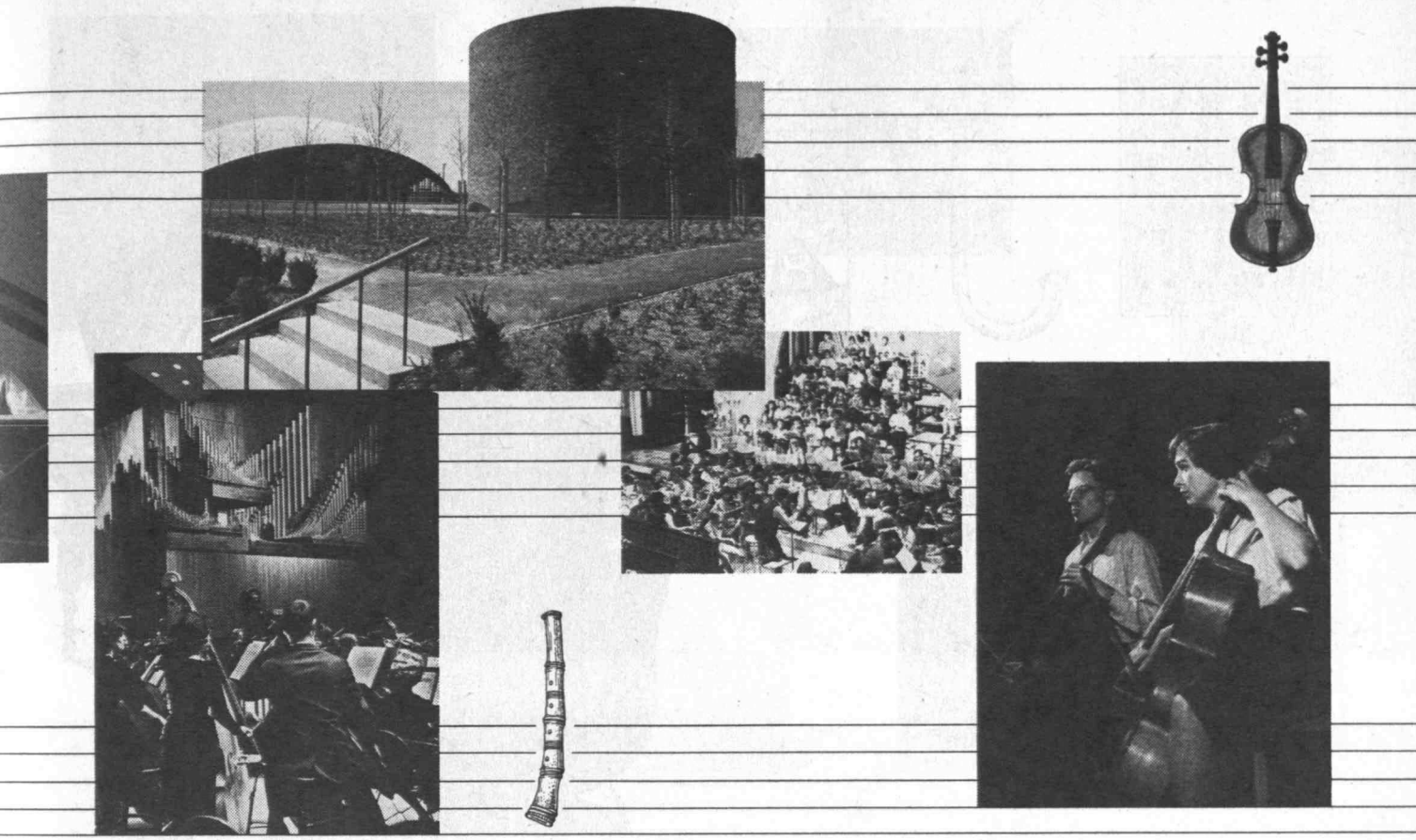
For instance, everyone leaned forward as Gregory Fritze, who had come over from the Berklee School of Music to conduct his Jupiter Effect, *explained how he tried to express something about the alignment of the planets this name describes when he wrote the piece in 1982.*

As the concert continued, it kept being "discovered" by students who plunged in that absorbed-M.I.T.-way out of the corridor and into the lobby.

At M.I.T., the people who teach music are in a "Section" of the Department of Humanities. According to a lot of people, both inside and outside of M.I.T., it's different here. Why? Let Marcus Thompson answer:

"All of us, professors and staff, are performing musicians. It's a real credo. For us, music is a living, active art form . . . our training, focus and life might be different—some of us are more active as theorists or composers—but each of us has a performing outlet.

"What I find appealing is that we combine some of the best features of two extremes, the conservatory and the liberal arts college. We aren't preparing professional musicians as they are in the conservatory. That gives us a chance to pursue a kind of overview that concerns music in terms of culture and in terms of society. . . We have more musical activity, led by major performers who are active in their fields, than almost any liberal arts college I could name."



1952: *The Choral Society performs with members of the Boston Symphony Orchestra (BSO) Chamber Orchestra, the first of many collaborations between BSO and M.I.T. musicians.*

1955: *Kresge and the Chapel are dedicated, marked by the commissioning of* Canticle of Freedom *by Aaron Copland, and the combined performance of Haydn's* Creation *by the Glee Club and Choral Society with a chamber orchestra of BSO players.*

Course XXI is established and a major in humanities is offered.

It's part of M.I.T.'s folklore that an increasing number of students come here for the science/engineering and for the chance to participate in and hear music. A great number of them cluster around John Corley, the first person brought to the Institute by the legendary Klaus Liepmann. Corley it was who founded that wind band playing down below. And Corley it is who gets so carried away by the thought of M.I.T. students and music that he almost starts singing when he talks about them:

"A sustained chord in the concert band is a very living thing. It's windblown, propelled by the human body . . . a little more vibrant than an organ would be although the procedure, air blown through a pipe, is the same. As a living thing, it's beautiful! And subject to such minute inflections.

"I love working with the students here. There is a difference. I remember when I first came and said to them, 'When you get to this passage, make it short.' They all reached for their pencils and made notations on the music. It was astonishing. I will say 'Tie this note across the bar line' and I see them pause for a second and think how to do it.

"They are so sensitive and they stay with you in a way that really is unique to them. If I take a deep breath I feel the chord expand. Once in a concert I reached up to push my glasses back up my nose and got a crescendo."

In one sense, everyone involved knows that the large discussion of music myths and questions at M.I.T. could be extended indefinitely. There are many ways of approaching it. For instance, says Corley, "I have felt it behooves me to do what I can to encourage that intellect, that music, not to hold it down."

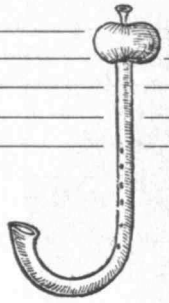
Thinking about how the band, with such exurberant energy, has leaped during all the Corley years into so much music that it had commissioned fresh out of the minds of composers—and quite a few of them students in the band—brought me to reflect that M.I.T. at separate times reached into the great world to commission works from both Bohuslav Martinu and Aaron Copland.

In the world of making music, nothing else can be quite like the actual writing of a new work. Of the composers at M.I.T., perhaps the most recognized is John Harbison, Class of 1949 Professor of Music. That giant of music Bostonians refer to so casually as the BSO has commissioned him twice, including for his Symphony No. 1, premiered by the orchestra last year, with Seiji Ozawa conducting.

In a long appraisal of Harbison written for the *Atlantic Monthly* last spring, Lloyd Schwartz said, "His music is more memorable, more moving, and less easily pigeon-holed than the music of anyone else in his generation."

In recent years grants, awards and commissionings have come frequently to composers here, with Harbison, Ed-

100 YEARS OF MUSIC AT M.I.T.



1954-59: *Pianist and composer Ernest Levy (above) is artist in residence and faculty resident in Munroe House.*

1956: *John Corley takes over conducting the Symphony; the Glee Club makes the first European tour, and repeats this successful venture in 1958 and 1962.*

1956: *M.I.T. buys its first harpsicord (above) using funds from* parking fines.

ward Cohen, David Epstein and Barry Vercoe leading the list, not necessarily in that order.

Marcus Thompson, needing more music for his beloved viola, frequently commissions new work. At the center of the Experimental Music Studio's endeavors is the encouraging and commissioning of new music.

At this point, there are so many composers at M.I.T. that they formed part of the raison d'etre for the Boston Composers Project, founded and directed by M.I.T. music librarian Linda Solow.

"It was such a good feeling when John (Harbison) performed his new work with the BSO and was here at my desk a few days later with a copy of the score and a cassette recording of the performance," Solow said.

No one has ever before created anything like the Composer's Project. Sixteen Greater Boston Music Libraries, led by Solow, developed an ongoing system for lifetime "adoptions" of all contemporary composers writing jazz and art music in the Boston area. M.I.T.'s Library is homebase for 17 composers, most of them connected with the Institute. The project is elaborately cross-referenced, keeping biographical information, sheet music, recordings, and histories of individual works. Most important, it gives performers and music leaders a quick and easy way to find arrangements suited to their particular instruments or to particular ensembles of musicians.

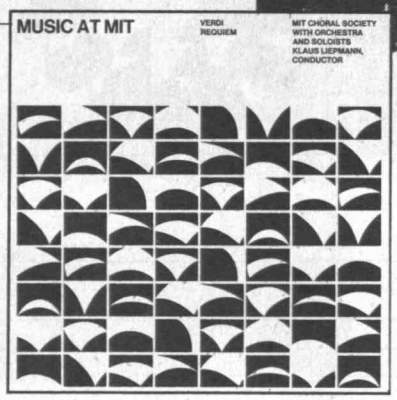
Not even Liepmann, who originally insisted that M.I.T.'s Music Library had to aspire to the same level as the most serious "book" libraries, imagined that a librarian here would first dream of and then achieve a project that would mean so much to the present day and future making of music.

That kind of involvement with music, along with connecting M.I.T. students to music in some more profound way than the "music appreciation" mode of the past, contributes to the distinctively different character of the day-in-and-day-out music life here. There is a vision that began, strongly, with Liepmann. And it has been meditated, continually re-interpreted and carried on by his successors.

John Buttrick, Liepmann's immediate successor as head of music (1972-76), said: "Klaus was concerned that M.I.T. students might not relate to the most humane of all the arts. That concern was our common meeting ground. He couldn't go for still another professional music program—the world didn't need one more."

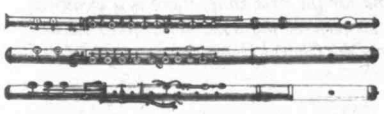
Liepmann did not want to collect a group of distinguished "artistes" to become a Tiffany's window display, designed to "prove" that the place must be cultural. He wanted a native musical culture to build from the inside out.

Liepmann: "(Rudolf) Serkin cautioned me about going to M.I.T. He said, 'These students will not have enough



1963: *The first of the Spring Festivals of Music, with Randall Thompson (above) conducting the Concert Band and Glee Club in his* Testament of Freedom.

(Top) Herb Pomeroy conducting the Jazz Band; (above) the Jazz Band.



1963: *Herb Pomeroy arrives and launches serious jazz at M.I.T.*

technique for their music.' And I said, if I have to choose between the technique and the spirit, I prefer the latter."

In that vein, Buttrick said he felt "vested by Klaus." When he begins to explain, it's a rare pleasure to watch Buttrick start off quite calmly and then suddenly lift into a kind of singing speech.

Buttrick begins, "It's a school of technology. You have minds constantly confronted by and coping with tasks that are part of the political-sociological-economic system of our contemporary world. That is what a lot of energy is doing here."

And now the lift-off: "We could not go into music in any sort of precious way. We had to try to introduce a student to that part of himself he knows not, but which is there. And that, in fact, is what the arts in their best life—if they do not become part of the task-oriented world—blend into, that ever-stable, ever-thirsty and ever-hungering part. It is there, and especially in students with the well-developed minds. To not deal with it is to deny our roots—not our immediate ancestral roots, but way, way back in time."

Which inevitably brings to mind Stephen Erdely, who came to M.I.T. after 16 years as violinist with the Cleveland Symphony Orchestra. He is part of an international team working on the collection and study of folk songs of his native Hungary and has a dream of bringing about—through studies of folk music—some greater consciousness of world neighborliness. Erdely talks about whether ancient folksongs will "lose their freedom" in the modern world and how his work has encouraged him. "I see more and more that a strong music tradition existing for a thousand years will not change in 40 or 50."

Thinking of Erdely and considering the composition of M.I.T.'s student population (foreign nationals usually make up 20 percent of the 9,500 students) it is appealing to dream that something as yet unknown will happen. Some new synthesis that has a chance because of the juxtaposition of Erdely with such a richly international student body.

Next year he will begin a new class in world music, tracing music through centuries of interweaving paths among peoples. For instance, there is an exciting new discovery by a Peking scholar who found Hungarian music in western China, "probably from the Huns," Erdely said.

In the middle of the costumed-concert in Lobby 7, the stream of people heading out of the main corridor toward the front door suddenly yielded a young mother pushing her baby in a stroller. When she saw the rich fantasy of dress and felt the reverberating pulse of the music, she came to a quick stop. The baby, suddenly plummeted into the middle of the spectacle, raised both arms, kicked her feet and, laughing, began what looked like a happy squeal, though the sound was absorbed in the music.

100 YEARS OF MUSIC AT M.I.T.

(Above) David Epstein.

1964: *John Oliver (top) joins the faculty, and works with Liepmann conducting the Glee Club and Choral Society.*

1966: *David Epstein joins the faculty and takes over the Symphony; the Wellesley exchange begins and for the first time, there is a wealth of string players for the Symphony; John Cook launches the Chapel Concerts.*

(Above) John Buttrick.

Buttrick—along with others at M.I.T.—does have a distinguished career as a performer (a pianist, he presents concerts and makes recordings here and abroad). Yet he talked recently of how proud he is of his part in founding the Piano Lab. A laboratory for classes in the fundamentals of music, this workshop teaches sight-singing and ear training by allowing rank beginners and others to sit down at the keyboard "and begin to put their eye and hand and sound impulse together," as he describes it.

Variations of this extraordinary approach are taken by all the beginning subjects. This is surely an important factor in lifting music into the large and tall place it occupies in the life of the Institute, according to Buttrick. Enrollment in music classes went from around 400 up to 1200 in just a few years after Piano Lab began.

In the recent past this enrollment has declined, and Buttrick, for one, plans to go back to teaching introductory classes next year. These are labor-intensive and exhausting for teachers; they need a lot of energy to keep going at a strong level, Buttrick says. "But they are the big rolling belly of music here. We have always wanted hundreds and hundreds of students in those courses, and we still do."

Performance: A Gift Both Kept and Shared

Strongly in the line of the Liepmann vision are the 14 music performing groups at M.I.T., formed by auditions and open to everyone at the Institute.

The Choral Society is the only group extending in an unbroken line back to 1884. But the M.I.T. Symphony has a long history, and now stretches continuously from 1945. Conducted by David Epstein, it grows stronger every year, with an ongoing life of inviting great soloists, recording, touring, and appearing in places like Carnegie Hall.

Epstein joins the discussion of whether an M.I.T. student or scientist relates to music in a different way: "I can rehearse them in a way that would be impossible with other kinds of musicians because of the way they conceptualize structure on the page and in their heads."

Known not only for conducting but for composing and for his studies of time in music, Epstein founded last year the New Orchestra of Boston. It is made up of musicians from the Boston area's large freelance community and from selected players among the faculty, staff and students of M.I.T. Among other tributes, this group was praised for its "joy in playing" as orchestra-in-residence at the Mozarteum during the famous Salzburg Summer Festival.

One of the newer groups here is the M.I.T. Chamber Ensemble, founded by Marcus Thompson with an ideal of creating space and time for some of M.I.T.'s finest musicians to present chamber mu-

(Top) John Corley.

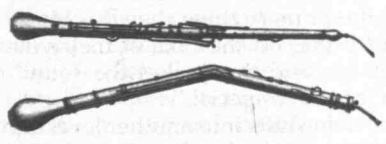
1968: *American composer Elliott Carter is visiting composer and humanities professor.*

1970: *The M.I.T. Jazz Band is one of only three American groups invited to the European Jazz Festival, Montreaux, Switzerland.*

1972: *Liepmann (above) retires: pianist John Buttrick, who joined the faculty in 1967, is named director of music.*

sic concerts with some of Boston's most respected performers, including members of the BSO.

I noticed the absorption of one slender man in a well-worn windbreaker and casual clothing who stood throughout the entire event, leaning on the railing of the second floor balcony. His companion seemed equally at home sitting on the floor, leaning her head to look down through the bars. Students, cleaning men and others walked past them without a second look. It took me several discreet glances before I realized they were Mr. and Mrs. David S. Saxon. (He is chairman of the M.I.T. Corporation.)

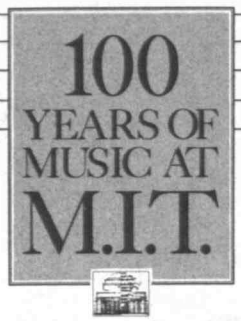


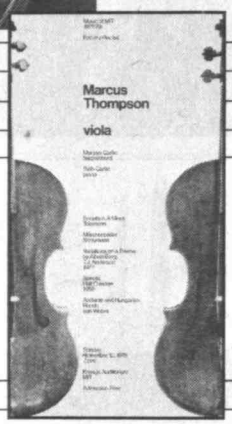
Artists, Intellectuals and Political Ferment

With that picture in mind, I think of stories about M.I.T. in the early 70's, when many college students struggled both against US policies in Asia and also against some of society's long-standing forms, such as too-rigid hierarchies. To me the freedom and beauties inherent in the fantasy of the Halloween concert—with the Saxons absorbed as anonymously as the rest of us—seemed to be a reward for that struggle, and in some way almost a promise.

Buttrick and others remember a transcendent moment in the life of Klaus Liepmann, who fled to this country from Germany in 1933. With M.I.T. deep in the turmoil of student uprisings in 1972, Liepmann stood to speak for his first and only time at an M.I.T. faculty meeting. He referred to his youth in the Hitler years. Impassioned, he spoke for the visions expressed by the protesting students, saying: "I feel it our duty as intellectuals and artists to speak up now and to act now." There was a three-minute standing ovation, with Liepmann the only person seated in the hall. The faculty sent a strong appeal to President Nixon; classes were suspended for two days of discussions and "teach-ins"; the speech was reported in the European press. And the director of music had played an unpredicted role in the working out of the whole story of that time.

Part of the unpredictable and "happening" aspect of the Halloween concert came about because it was taking place in Lobby 7, the "Times Square" of M.I.T. Students hurrying out of the corridors in clusters of three of four stopped almost in mid-step and turned to join the audience on the floor. There were also some who did not stop, who walked intently all the way across the worn grey middle of the red carpet—not breaking stride, the rhythm of their legs weaving a visual counterpoint to the music of the band.





(Top) Marcus Thompson

1973: *The Glee Club and Choral Society merge, with Oliver as leader; the chamber music program, the Chamber Players, and the Experimental Music Studio are all founded.*

1976: *Violinist and ethno-musicologist Stephen Erdely becomes director of the Music Section.*

That brings up a question: Are there students too enmeshed in the pressure of studies and assignments to do any more than cast a quick glance at the warm lights as they hurry past and never go into the rich—and free—offerings of music? Attendance at concerts is often slimmer than hoped. But not always: A recent M.I.T. Symphony concert filled Kresge with a largely young, blue-jeaned crowd. Among other selections on a demanding program, they heard Daniel Goodman, a Ph.D. candidate in plasma physics, perform Rachmaninoff's second piano concerto with high spirits and technical command.

But the music people are deeply engaged with the attendance concern and its implications, and so is the rest of M.I.T. Thompson said, "There is a new vision developing, at least in the humanities and among some of the people in science and engineering to do something about relieving the pressures so the students can get a more well-rounded education."

Coming to the end of this essay's reflections, I return to two questions. First, does music sound different here?

Let John Oliver answer from his position as leader of both a professional chorale and the M.I.T. Choral Society: "The (M.I.T.) sound is 'younger.' You don't get the depth of sonority that you find in the professional, which is dark and rich. It is a younger, cleaner, airier sound. It's beautiful. Of all the volunteer singers I work with, only at M.I.T. is there this incredible energy force."

Second question: Are aptitudes for science/engineering and music different sides of the same mental coin?

Edward Cohen, who teaches most of the composition/theory classes, has a somewhat different slant on that one:

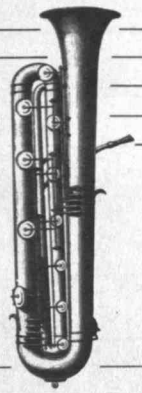
"I think the music and science thing is overdone. These people obviously are capable of doing science and technology. They are motivated and disciplined by nature, reinforced by their upbringing. This would also naturally pertain in their music."

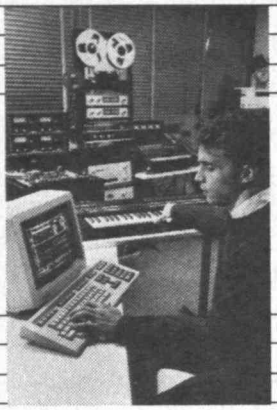
However, Cohen said, "They do learn fast. I've taught at other colleges and I find this the most intelligent student body I've seen."

At the end of all this, I know profound viewpoints must have been left out because I haven't talked with all of M.I.T.'s music people. But my explorations so far have left me with a sort of mind-song-scene. Like this:

Imagine a trumpet, and Herb Pomeroy (20 years directing jazz at M.I.T.) says: "These kids give me something special in my life . . . something very different comes about because music is not the primary thing they do. Music is the frosting on the cake of their young lives . . . and that makes the sound of our jazz very special."

Epstein shifts into another level of his usual intensity when he talks of how the good students keep coming more and





(Above) Halloween, '84 (Above) Linda Solow

(Above) John Harbison

(Above) Experimental Music Studio.

1981-85: *John Harbison, David Epstein, Marcus Thompson, and Jeanne Bamberger, each serve a one year term as director of music.*

1985: *(Above) Jeanne Bamberger, head of the Music Section, recent recipient of a $68,000 grant to study the development of musical intelligence.*

more. Their collective energies are gold for him, maybe because he dreams of sounds we haven't heard yet. "There is a careful shaping and projecting of music that I find only with them."

Cohen walks down the corridor with an armful of papers, his voice light. "I'm always amazed at how many very good students there are here and how many really want to write music."

Oliver, lifting his arms and stretching: "The relationship these people have to music is so—how should I put it—untroubled—and with such an understanding about what music is about. M.I.T. is astonishingly special in my life. I've never been seriously tempted to go anywhere else."

Buttrick swings around on his piano stool as he brings in a new note: "Back in the 70's when we took over from Klaus—remember, here we were, liberals, all of us, and people bitching about society—and we were here at this place where we could do something . . . and it was: stretching the horizons and helping the integration of the world. We must never lose sight of why we're here. What these students need from us is information, a lot of it, and a lot of heart, the heart of music, what it represents at its most global, what it does to people's bodies, souls and hopes."

And there has to be an end to the fantastical Halloween concert. I watched some of the students packing up the instruments and music stands, placing them into movable storage carts, six-by-three-feet in size, dumpster-shaped, with wheels.

On the Massachusetts Avenue crossing in front of the building, two of them waited with their unwieldy dumpster for the light to change. One said:

"Now, Doug, when it says Walk, I want you to boot it."

As the light blinked, they leaned into the heavy cart with such elan and loud yells that it took off and sailed across the street ahead of them, little wheels jumping it over the curb to land safe and upright like some child-built mechanical rhinocerous on the other side of the street. The students, all thin legs and sneakers, pounced on it a millisecond later, sending it racketing over the wide sidewalk toward the Student center.

"Ever stable . . . ever thirsty," free for the moment of "the task-oriented world." □

Technology Review is indebted to the photo research department of the M.I.T. Museum, to members of the music department, particularly John Buttrick, to Frank Revi, the Council for the Arts, China Altman, and the News Office for help in assembling the posters and photographs that accompany this article, and to Jenkins Associates for help in designing the pages.

Whitehead Dedicated to Biomedical Research

The Whitehead Institute for Biomedical Research, an independent basic research center affiliated with M.I.T., held an official dedication last December. The three-day, science-and-ceremony-filled occasion also included announcements of substantial funding for the Whitehead Institute from both government and industry.

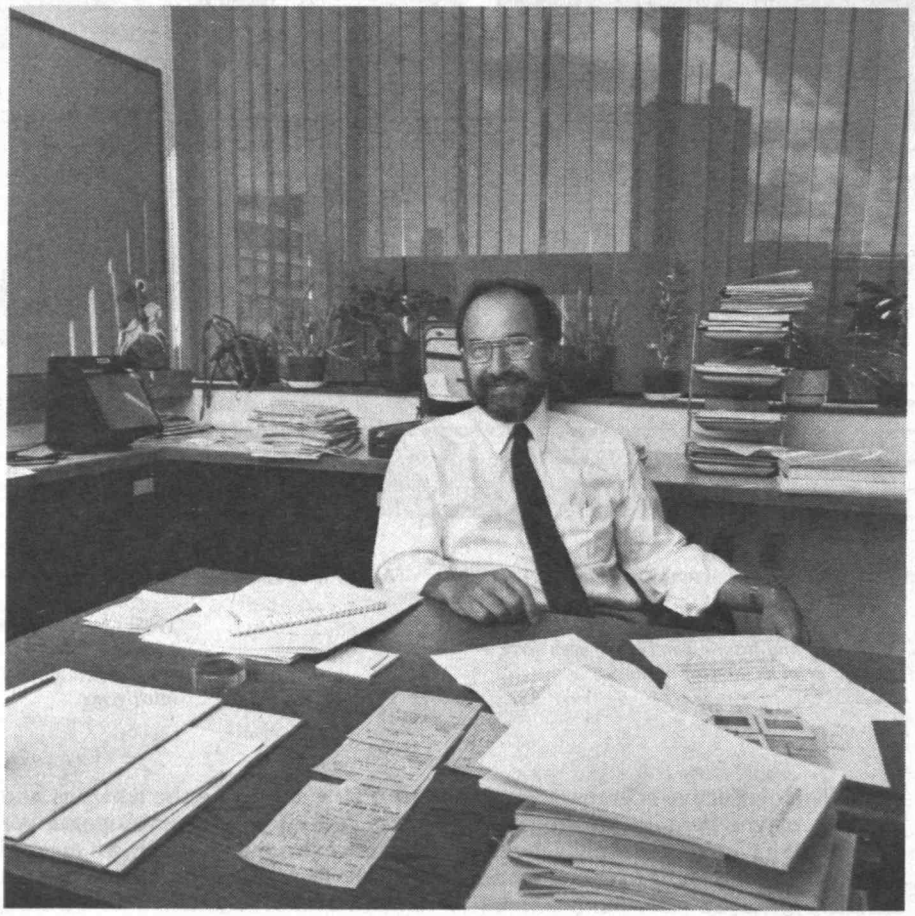
The dedication ceremonies focused in large measure on Edwin C. Whitehead, whose vision of a high-quality, independent research and teaching facility led him to collaborate with M.I.T. and with biology professor David Baltimore, the founding director of the institute.

The total value of Whitehead's support for the institute which bears his name will ultimately exceed $135 million—in the forms of a seven-story building worth $25 million, an endowment that yields $5 million per year in operating funds, and a bequest, plus a grant of $7.5 million to M.I.T. for two endowed chairs and other expenses related to the tie-in of the two institutions. Whitehead made his personal fortune in the biomedical field, with a laboratory equipment company named Technicon, and he said he "wanted to give something back."

The Whitehead Insitute is located in Cambridge Center, a redeveloped area on Main St. adjacent to the M.I.T. campus. It was launched in temporary space provided by M.I.T. beginning in 1982, and now has a complement of 200 scientists, students, post-doctoral fellows, and other employees. Its focus is on problems of developmental biology studied from a molecular perspective. Faculty-level appointments at the Whitehead may be considered for faculty positions at M.I.T. At present, all Whitehead faculty hold joint appointments, which entail the usual faculty responsibilities.

Arthur Smith, chairman of the faculty, notes that there is a clear administrative distinction between the operations of M.I.T. and the Whitehead Institute. But to M.I.T. students, he said, the Whitehead Institute will simply be another pool of talented faculty, well equipped laboratories, and research opportunities on the frontiers of biological science.

M.I.T. nominates three of the 14 members of the Whitehead's Board of Directors and takes a central role in the selection of the director.



David Baltimore, professor of biology at M.I.T., director of the Whitehead Institute

Du Pont to Provide $4.5 Million

The Du Pont Company of Wilmington, Del., took this occasion to announce a five-year, $4.5 million agreement with the Whitehead Institute. The agreement provides $900,000 this year, with future allocations adjusted for inflation. The agreement is the first contract the Whitehead Institute has signed with a company interested in biotechnology.

Speaking at a press conference, Edwin Whitehead noted that "there is no tangible, immediate value in this agreement to Du Pont," because it supports basic research in molecular genetics, not licensing rights for specific products. "This is a very unusual agreement," Whitehead said.

The agreement will foster collaboration in research between members of the Whitehead Institute staff and Du Pont, including the exchange of scientists and

PHOTO: WARREN ROOS

In his new book, Steven Levy puts the launch of the personal computer here, on the underside of the Tech Nickel Plate Railroad. Alan Kotok, '62 is working while Malcolm Laughlin, '59, watches.

sharing of facilities.

Under the agreement, Whitehead Institute scientists retain their traditional freedom to determine their own research directions and freedom to publish the results of research performed with Du Pont support. While the specific projects to be funded have not been decided on, Baltimore expects that some Whitehead researchers will be doing more work in the area of plant genetics. He will be in charge of allocating the funds, after consultation with Du Pont.

The Whitehead Institute will also retain ownership of inventions that arise from Du Pont sponsored research. Under the affiliation agreement, net revenues from the licensing of inventions at the Whitehead Institute will be shared equally with M.I.T.

Private Support is Only the Beginning

Also coinciding with the dedication was the Whitehead Institute's announcement that several of its scientists have received major research grants. The grants are:

☐ A five-year, $5 million grant from the National Institutes of Health (NIH) for a major study of oncogenes (genes which cause normal cells to become cancerous). The study will be directed by Baltimore, Robert Weinberg '64, Richard Mulligan '76, and Rudolph Jaenisch, and will involve the work of 18 other scientists.

☐ A lifetime research grant from the American Cancer Society for the 42-year-old Weinberg, which provides partial salary support until he retires.

☐ A Research Career Development Award from NIH to Mulligan, which provides five years of salary support.

While some of the Whitehead Institutes's operating expenses are carried by endowment income, Baltimore explained, most of the funds for ongoing research must come from outside sources, particularly the federal government.

"These grants are absolutely essential if we are to attain our research goals," he said. ☐

M.I.T. Hackers Led a Computer Revolution

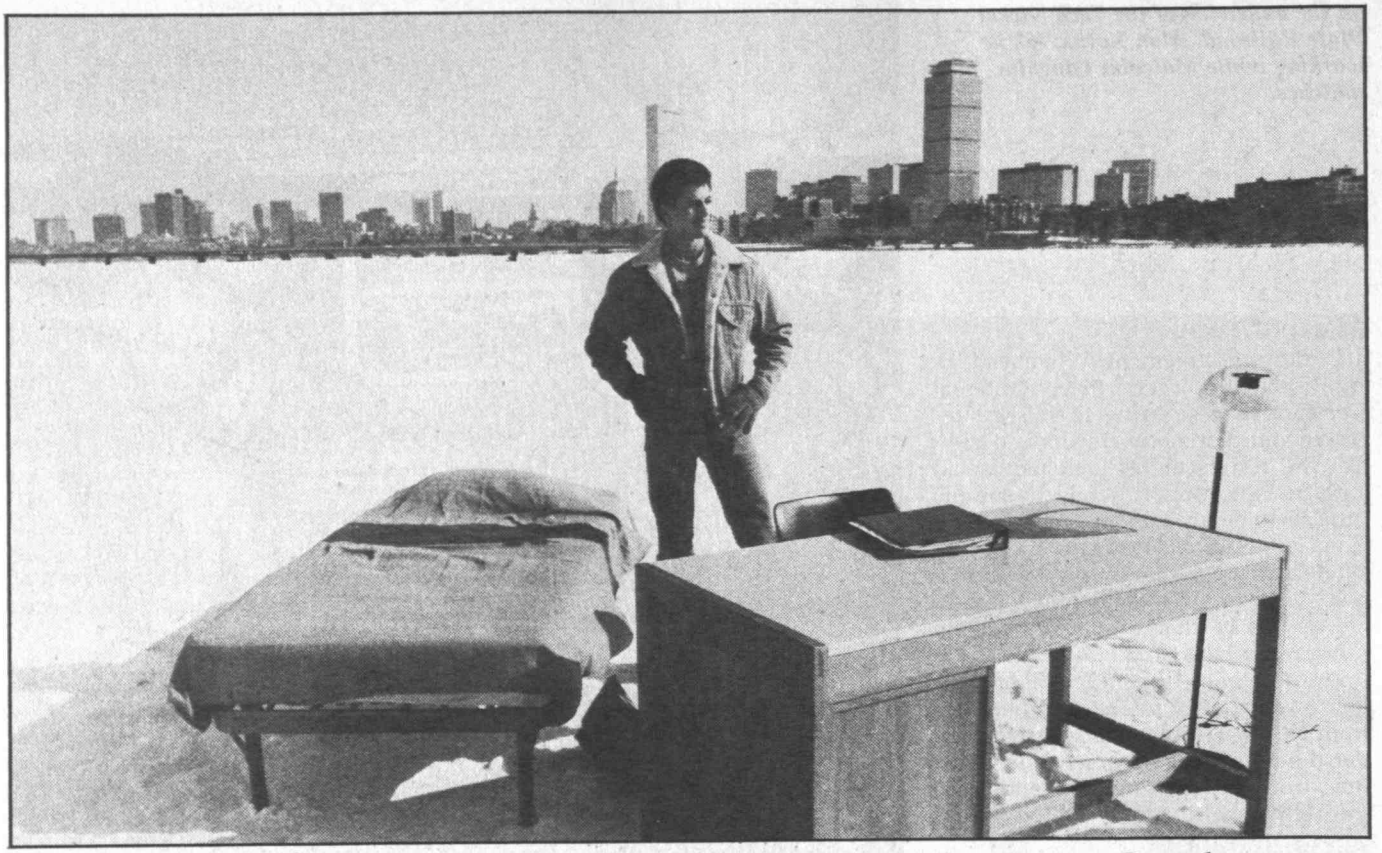
The idea that a computer can be a personal partner and a social force was born among "hackers" lying on their backs under the Tech Nickel Plate Railroad—the Tech Model Railroad Club (TMRC)—in the 1960s.

These young men are the heroes of a new book, whose first section is set mostly at M.I.T.: Steven Levy's *Hackers* (Anchor Press—Doubleday, 1984, $17.95). They were chiefly students but also included some teachers and a few drifters, "who most clearly saw why the computer was a truly revolutionary tool.

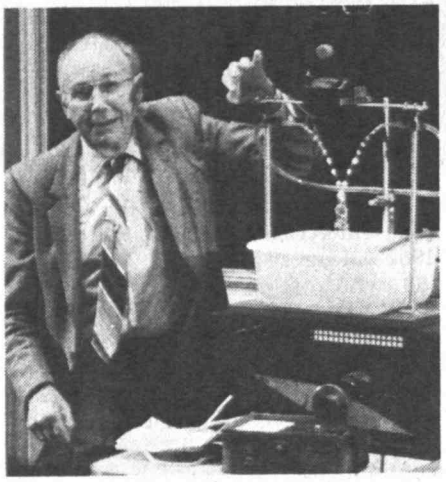
"As I talked to these digital explorers, . . . I found a common element, a common philosophy of sharing, openness, decentralization, and getting your hands on machines at any cost—to improve the machines, to improve the world," writes Levy.

The first heroes are Peter Samson, who entered M.I.T. with the class of 1962 but never graduated; Alan Kotok, '62, who rose to become president of TMRC and now is a senior scientist at Digital Equipment Corp.; Professor John McCarthy, '46, who taught 6.641 in the 1960s while busy with ideas to which he eventually gave the name artificial intelligence; and Jack B. Dennis, '53, who continues as a member of the M.I.T. faculty. From designing complex train control systems, its protagonists advanced to "hacking" the telephone company's newborn computers into giving them free long-distance calls, all the while "lock-hacking" to liberate the tools and components they needed from Institute storerooms. Eventually came the inevitable confrontation with the "system"—those who would set up priorities, passwords, and charges for computer use. It was a prolonged, nationwide confrontation marking at once the maturation of computers and the achievement of the hackers' dreams of personal access to computer power. ☐

PHOTO: CURTISS WILER, '63, FROM THE M.I.T. MUSEUM



Freshman Ted Larkin's friends moved his dormitory room furniture into spacious Charles River accommodations in what became the most publicized event of the 1984-85 hacking season. (Photo: Joe Dennehy, the **Boston Globe***)*



Stroll through "Strobe Alley." Watch its proprietor, Professor Harold E. ("Doc") Edgerton, '27 (above), explain how drops can be made to rise out of a dish of milk. See elapsed-time pictures of starfish, sand dollars, and sea urchins skittering across the rocky bottom of Hodgkins Cove, Mass. Watch and listen as corn pops, bats fly, and glass breaks. It's all on a new 50-minute color video tape available (VHS halfor three-quarter-inch) from the Alumni Center, Room 10-110, M.I.T., for $20. (Photo: Steven H. Wheatman, '86, from The Tech)

Study This Summer in Cambridge and Europe

In addition to an ambitious program of more than 75 one- and two-week intensive short courses on the campus in Cambridge, M.I.T.'s 1985 Summer Session will include 15 such programs at the University of Stirling, Edinburgh, Scotland.

Cambridge courses range from professional planning for architects through chemical process control, management, electronics, flight stimulation, and nuclear reactor safety. The 15 short courses in Edinburgh include such engineering topics as gas turbines, tribology, data communication, biotechnology, and corrosion.

Some 1,900 professionals in architecture, engineering, management, science, and the social sciences attended summer programs on the campus in 1984. For further information: Director of the Summer Session, Room E19-356, M.I.T., Cambridge 02139. □

Iacocca to Speak at Commencement

Lee A. Iacocca, chairman of the board and chief executive officer of Chrysler Corp., will speak at M.I.T.'s Commencement on June 3.

Faculty, staff, and students on the Commencement Committee recommended Iacocca to President Paul E. Gray, '54, and Gray issued the invitation. Iacocca is said to have chosen M.I.T.'s for acceptance from a large number of speaking invitations.

L. A. Iacocca

Iacocca is an engineering graduate of Lehigh University (1945), and he holds a master's degree in mechanical engineering from Princeton (1946). He joined the Ford Motor Co. upon leaving Princeton and in 32 years rose to the post of president and chief operating officer before moving in 1978 to Chrysler Corp. It's there that he had cemented his reputation as one of the nation's dynamic and successful industrial leaders.

Some 1,500 M.I.T. degrees will be awarded at the Commencement Exercises on Monday, June 3.

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An oversight on my part has delayed my reporting that a new bridge in Allegheny County, Pa., was named for our classmate, **Levi Bird Duff**. The bridge, opened in the fall of 1983, is 830 feet long and crosses a ravine through which runs an important highway. The bridge connects two Pittsburgh suburbs. Lee came to the county in 1936 as chief engineer, and for the next ten years was in charge of designing the county's major construction projects, including three bridges and a highway cloverleaf. In 1946 he was appointed director of the works department and became responsible for engineering, construction, and maintenance. Among his accomplishments was an improved design that saved $500,000 in the repair of a fire-damaged bridge. He held the director's post until 1972, two years before his retirement, and for two more years was an official consultant to the county. Since then, at his own request, Lee has worked three days a week as an unpaid consultant, and is still called "director" by those with whom he works. County officials call him their "walking encyclopedia" because of his knowledge of county roads and bridges and what lies under them. He has spent much of his time in recent years in writing down that information for the use of future employees. In naming the bridge for Lee, the chairman of the board of county commissioners said that that action was little to do for a man who had done so much for Allegheny County.

Ros Barratt wrote last fall that he seems to go on "like the brook" and still has three churches to do in Ecuador.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

15 70th Reunion

Happy spring, '15ers! The Easter season is upon us and good refreshing weather!

Loring Hall has forwarded more 1913 diary notes, which, from the responses, you are truly enjoying. In his note to me (while recovering from eye surgery), Loring recalls M.I.T. Summer Camp, (attended only by those who took Course I, civil engineering) which had its first session in 1912. Prior to 1912 all the practical applications of surveying principles had to be carried out in Boston and vicinity. The move to Maine not only provided a much more suitable field of operations but gave the students a taste of a wonderful way of life. Those who were privileged to spend those eight weeks in Maine, in 24-hour contact with faculty and classmates, gained something always to be cherished. Loring was doubly blessed by spending a second summer there as an instructor. So now on to his diary notes:

August 8, 1913: At M.I.T. Summer Camp had stream-gaging this morning, then after dinner made a compass traverse in a field a mile from camp on the road to East Machias. The meals are excellent, with dinner at noon and supper at night. With all the outdoor work, we have tremendous appetites.

August 9, 1913: This being Saturday we only worked in the morning. There was a baseball game in the afternoon between tent rows. Our side lost. Dick Hefler made our only run. In the evening we elected officers: Chairman, **Marshall Dalton**; House Committee, **Pop Wood** and **Art Bond**.

August 10, 1913: Got up before 5 a.m. **Jack Stevens**, **Al Clarke**, and I rowed five miles up the lake to an inlet where the pickerel were supposed to be biting. We used spoons and spinners, but had no luck, so caught some frogs and tried them. Still no strikes. Had a swim on our return. Water is crystal clear and very cold. In the evening Dean Burton entertained us with an illustrated lecture on his travels to N. Greenland and South Africa on missions for M.I.T.

August 13, 1913: Worked with Sam Fox on a transit traverse, using the DMD method. Sam had been to Princeton. He says nobody works hard there, so nobody learns anything.

August 14, 1913: Had a general meeting and elected a Boat Committee, consisting of **Waldo Pike**, **Larry Quirk** and me. Our job is to keep track of all income from the boats and see that they are kept clean and in good repair.

August 15, 1913: **Sam Fox**, **Dick Hefler**, and I made a triangulation measurement from Beamis Hall to Chase's Signal. It was 85,000 feet.

Thanks again, Loring! We love what you are doing for '15ers. . . . We recently had tidings from one of our California classmates, **Francis Hahn**, who is truly enjoying life!

Now for our sad news. **Joseph Woodward Barnwell**, who built many bridges in Virginia, passed away at the age of 93, and we wish to express our deepest sympathy to his three daughters and their families. . . . **Herman E. Morse**, who has been so ill, passed on. I have such fond memories of sitting across from his daughter and son-in-law at the 50th reunion banquet table while Herman and his wife, Marjorie, were enjoying '15ers throughout the room. The four of them drove to Cambridge from Akron, Ohio. He will be sadly missed by Marjorie and his family, who were very devoted. . . . Janet Gray advised me that her great dad, **Sol Schneider**, passed away. You will recall he was looking forward to the 70th reunion this year—he said "at least in spirit!" Sol loved his '15ers and M.I.T., and his daughter asked friends and relatives to make their donations to the scholarship at M.I.T., which surely would please him!

Carl "Pop" Wood passed on in Peterborough, N.H. on October 19, 1984, leaving his wife Charlotte. I have such fond recollections of once visiting their beautiful home and surroundings. Pop was on top of "their mountain," in Peterborough, N.H. and came hustling down in his jeep when Charlotte rang the bell. We had a delightful visit (and enjoyed a delicious rhubarb drink). His nephew, Edward H. Stone, writes: "He had been horseback riding up to a few days before his death. In addition to his wife, several nieces and nephews survive him. Carl's professional career was with the Metropolitan Water Works in the Boston area and with Stone and Webster Co. He also served as an engineer in the air force during both world wars. His specialty was laying pipe. He delighted in saying, 'I've laid a lot of pipe in my life, enough to stretch across the continent.' Carl loved sports and the outdoors. He was a life member of the Appalachian Mountain Club. He was also a loyal and active member of the Class of 1915."

About the 70th reunion: I truly would like to know if there are some '15ers who are planning on going to Technology Day this coming June. I would appreciate it if you would so advise me, and perhaps we could get some kind of a gathering put together for however few may be able to be present.

As ever, and with all my best wishes—**Joyce E. Brado**, Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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We can all appreciate how the cold wintry weather in many areas of our country will keep many of us housebound. However, this kind of weather also seems to leave many of our classmates tongue-tied or afflicted with writing paralysis. We haven't had any letters for months.

By making a few phone calls, we were able to learn that Frances and **Henry Shepard** and Grace and **Dan Comiskey** are feeling fine and are truly hibernating within their homes during the cold weather. Occasionally Henry is able to venture out for a walk. Dan has put his car in the garage for the winter. . . . **George Ousler** is doing fine now but recently slipped on the ice and fractured his hip. . . . **Paul Duff,** at the time of our recent telephone conversation with Frances, had just returned home after three weeks in the hospital with pneumonia. Frances was very happy to have him home, and she reported that "those visiting him in the hospital left with a feeling that they'd learned something new and important from dialoging with Paul." We remember Paul for his great wit and the special way he tells a story, but (as he continues to demonstrate) he is a fountain of enlightening and uplifting knowledge.

Barney Gordon's son, Gene, says that Barney is feeling well and doing fine. . . . There was no answer to our call to Anne and **Izzy Richmond,** which could mean that they are enjoying their annual winter visit to Spain. . . . We had a nice note from **Don Webster**'s widow, Marjorie, telling us of Don's peaceful passing. **Dan Comisky** recalled meeting Don early in their days at Tech when they tried out for the relay team. Both of them made the team. Dan recalls that it was a long day when they left classes at Copley Square, they took the streetcar to the athletic field in Brookline, and after practice didn't get home (to Dover) until 7:30 or 8:00 p.m. . . . We regret to report the death of our classmate, **Walter Metz,** in Palm Springs, Calif. on October 2, 1984.

Keep eating, drinking, walking, breathing—everything in moderation. And, please take a few minutes to write a few lines to let us all know how you are getting along.—**Bob O'Brien,** Acting Secretary, H.E. Fletcher Co., Groton Rd., W. Chelmsford, MA 01863

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Atwood P. "Brick" Durham of Wellesley, Mass. died on December 23, 1984. In World War I, he survived the torpedoing of troopship *President Lincoln*. . . . It is reported that **Stanley Chisholm** of San Diego, Calif. died sometime in 1983.

Osgood "Ossie" Holt, in Woodland, Calif., writes that he is "comfortably located in a modern retirement home with a No. 1 nursing home and an excellent activities department." He says his reason for living there is to be near his only granddaughter and her two children, a girl 13 and a boy 10. His principal hobby is playing the piano regularly at the nursing home on Saturday mornings for an hour before dinner.

Ossie writes, "I am forced to use a walker and have been wearing braces on my feet for some time. One sad thing happened to me—I had to sell my car in the spring—just like parting from an old friend." Apparently, however, buses are available to meet his needs.—**Walter J. Beadle**, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

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You plant seeds, and you are returned wonderful fruit. My seasons good wishes to you have come back as warm year-end greetings from **Bob Greely, Herb Larner,** Rhoda and **Charlie Taverner,** Margaret and **Paul McAllister,** and **Myron Adams**. **Arthur Williams** writes that he had a car accident in May, is still in pain, but is improving. He had a birthday in August and was 70 again (for the 20th time). . . . **Stuart Caldwell** states he leads a quiet life in Rockport, Mass. but occasionally takes an exploratory trip—maybe to Arizona in January 1985 as a change from the rugged winters at the edge of the Atlantic Ocean.

George Woodruff reports on his community activities (good work, George): "Georgia Tech and the Westmister schools here in Atlanta have recently added my name to a building—a dormitory at Tech and a new library at Westmister. Emory University built a new gymnasium which was dedicated about a year ago as the 'George W. Woodruff Physical Education Center.' Of course, I am very proud of these buildings on the campuses of three fine educational institutions."

From Pomona, Calif. comes this warm note from **Georgius Cannon**. "Another year has passed, and I am still alive and well. As far as I know, I am the only one left of our M.I.T. franternity group and am the only one of my family still alive. You tell me you expect to go to a retirement home. I hope you will find it as excellent as ours is. We have a medical unit, a lodge for those unable to care for themselves, and individiual cottages and units. We have wonderful medical care. I often think of Boston and the wonderful years spent there. M.I.T. has changed tremendously since we were there. It has grown so big, so impersonal, I'm afraid. But I have always found the work I did there far superior to the schooling of any of my acquaintances. Who will keep up the class news when you get into the retirement home? It is very warming to know that someone from years ago remembers us. I often feel like the servant in the book of Job who said, 'I alone am left to tell the tale.' I hope we shall continue to hear from you."

Space requirements will postpone until the next issue of the *Review* additional letters of year-end greetings. . . . Regretfully, I conclude with news of the death of **Kenneth Pote** on July 29, 1984 and **Elbert Bancker** on July 5, 1984. No further details available. . . . We are indebted to H. Gregory Platts (son-in-law) for the following report from the *Washington Post* of the passing of **Albert F. Murray** on October 5. A retired radio and television research engineer, Mr. Murray died at age 90 of congestive heart failure on October 8 at the Carriage House Nursing Home in Bethesda, Md. He had lived in Washington since 1940. Mr. Murray was born in Huntsville, Ala. He earned bachelor's degrees at Maryville College in Tennessee, at Harvard, and at M.I.T. During World War I, he served in the Army Air Service and later was a research director in Philadelphia for RCA Victor television and for Philco television. During World War II, he worked in the radio communications and guided missile division of the old National Defense Committee. Since the end of the war, he had worked as an independent consulting television engineer based in Washington. Mr. Murray was a member of the Institute of Radio Engineers, the Society of Motion Picture Engineers, and the Chevy Chase Club. He is survived by his wife, Elizabeth, of Washington; two sons, Albert F. III, of Bethesda, and Henry W., of New York City; a daugther, Elizabeth M. Platts of Bethesda, and six grandchildren.—**Max Seltzer,** Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

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Received a holiday greeting from **Robert B. MacMullin**, part of which I can do no better than to pass on to you: "A free ride on the Zodiac Special; our engine is still on the track. We're rolling, click clickety clack. Our pressure is low, we're forced to go slow; for the holiday season, we're back. So ding-a-ling and toot-toot, at the end of our circular route. We're back in December, a time to remember, our oddments of news to commute. The crew has no serious medical problems, just the frailties of old age. For charms, we swallow pills. For amulets, we carry canes."

A Christmas card from **Doc Flynn** expresses his pleasure at hearing from **Ben Bristol** and **Russ Palmer** after our 65th reunion. He writes that 1984 was chiefly notable for the advent of a second great-grandchild. . . . **Francis Weiskittle** sends thanks to your secretary "for his fine work for Class of 1919."

We regret to report the death of **Joakim Lehmkuhl** on October 10, 1984 at his home in Nassau, the Bahamas, in his 89th year. These pages do not permit a story of his extraordinary career but only a few highlights. He was born and educated in Norway. He had a thriving radio manufacturing business and was the head of an anti-Nazi newspaper in Oslo. When the Germans invaded in 1940, he and his family crossed Norway on skis and finally reached the safety of Britain's Orkney Islands. Over here he received a B.S. degree in business administration at Harvard and an S.B. in electrical engineering from M.I.T. He bought into the Waterbury Clock Co. As president, he made its successor, the U.S. Time Corp., a worldwide enterprise and the country's largest watch manufacturer. He became Chairman of Timex Corp., from which he retired in 1973. We think you will be proud to know of such a member of our class.

Here's hoping you all enjoy a good summer ahead. Let me hear from you.—**W.O. Langille**, Secretary, P.O. Box 144, Gladstone, NJ 07934

20 65th Reunion

The listing of classmates attending graduation exercises in November/December's *Review* occasioned some favorable response. **Buzz Burroughs,** and **George Wilson,** and **Frank Maconi** phoned, and an interesting letter from Sumner Hayward, '21, commented on several classmates. Sumner used to live in Ridgewood, N.J. and **Frank Bradley** once lived in his home, as did **Mal Lees**. He knew **Pete Lovedan** because he worked for Liquid Carbonic Co., and he mentions **Bat Thresher** as bringing fond memories to all honorary secretaries "because he was such a nice guy to correspond with." I'll second the motion, Sumner.

Word comes from Mrs. **Fraser M. Moffat** of 18 Lake Ave., Montrose, Pa. that Fraser died on October 24. After graduating from Williams College before coming to the Institute, Fraser joined the army as a second lieutenant of infantry, was commissioned to lieutenant colonel, Chemical Warfare Service, served in France, and was promoted to colonel. After retirement, he became associated with U.S. Industrial Chemical Co., National Aniline and Chemical Co., and American Cyanamid Co. He leaves his wife, Lydia, a daughter, a son, and three grandchildren.

Christmas greetings gladdened the heart of your secretary. Among them were **Al Burke, Buzz Burroughs, Buck Clark, Bill Dewey,** Vera (Mrs. **Homer) Howes, Ned Murdouch, Ming Pai, Lee Thomas,** and **Phil Wait.**

Bink Carleton writes that he and Ann made the Royal Viking cruises to Canada, New England, and the British Isles. . . . **Al Fraser** writes that he has been operating his florist business in Wellesly since 1924. . . . **Sam Schenberg** writes, "The memories of our class continue to shine brightly with each passing year." He and his wife are looking forward to their 65th wedding anniversary next June. . . . **Henry Massey** writes that it is still marvelous that there are a lot of us around. He resides in South Chatham on the Cape. . . . **George Wilson** writes that he is improving in health and resuming his several hobbies and wondering what to do with his extensive mineral collection.

Word has just been received of the death of **William D. Shepard** of Winnetka, Ill. in January. No details. . . . **Bruce M. Steele** of 39 Cliff St., Burlington, Vt., passed away on October 14. His wife, Lois, thoughtfully supplied the following information. Bruce was a veteran of World War I. He was associated with General Electric Co. for many years and later with Western Electric Co. in Chicago. In later years he held various positions with the Munger Co. department store in Herkimer, N.Y., where he was born. He leaves a son. . . . Daniel Wolfson, '56, sends the sad news that his father, **Jim Wolfson,** died on November 14. Daniel says, "He had a strong commitment to his classmates and to the Institute as a whole. I am sure he will be at the 65th reunion in spirit if not in body." Jim was indeed one of the most loyal and faithful members of our good class. His absence will be sorely missed by us all. . . . **Freeman H. Dyke,** of 83 Fairview, W. Tequesta, Fla. died March 8 at his home. Freeman was vice-president of U.S. Metals Refining Co. He lived in Ohio, New Jersey, and Pennsylvania, and spent time in Colombia, Ecuador, Peru, Argentina, Venezuela, Brazil, Hawaii, Mexico, and the Bahamas. For a long time he was associated with Wheeling Steel Corp., ending up as manager. Retired to Florida, he remained active in fishing, golf, gardening, and photography. He leaves his wife, Katherine, two sons, both graduates of M.I.T., and two daughters.

Hope you have a healthful and pleasant new year!—**Harold Bugbee,** Secretary, 702 Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

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Here in Albany, N.Y. it is 9° above zero with a slight dusting of snow on the ground, and I'm writing for a spring issue of *Technology Review*.

Nelson (Ned) Lees, son of **Cornelia Nelson Lees** of our class, and director of Resource Development at M.I.T., wrote me that "Gracia Hunt McClintock has established an important scholarship fund at M.I.T. in memory of her husband, **Rodman McClintock**. Scholarships under the fund will be available to undergraduate students in the School of Engineering, and the first McClintock scholar was appointed in the fall of 1984. The action she has taken is a wonderful thing for M.I.T. because of the truly urgent need to provide more student aid support, which will assure that the very best qualified students are encouraged to come to M.I.T." Rodman McClintock entered M.I.T. with the class of 1920 in September 1916 and then left in June 1918, to return in Feb-

ruary 1919. He was recommended for a degree in December 1920 which was awarded in 1921. Consequently, his association with our class was not extensive, and he was little known by our class.

My lack of news and yelp for help a couple of months ago brought out responses from several classmates. . . . **Glenn Fargo** writes: "It was a pleasant surprise to see my name mentioned in the *Technology Review*. Our activities have been greatly curtailed, and I have been on a very limited schedule since my two hospitalizations. We have lived in St. Petersburg over 30 years and enjoyed it. Our present apartment is on a narrow strip between the bay and the gulf. Until recently, we have been active with bridge, golf, and traveling. I have fond memories of my years at M.I.T." Glenn's wife Helen added a footnote: "We have been married 58 years and have three children, five grandchildren, and five great-grandchildren—all in different places, including England and Germany."

Harold Cake of King City, Ore., writes: "Your appeal brought out my pen and paper to tell you all I know about classmates in the first VI-A course started in 1918. There were 27 of us in that course from different backgrounds, including eight from the west coast. Of the 27 original members I believe only five are living. **Ed Chilcott** has his own business in Los Angeles, **Bill Mathews** keeps busy on a mining project in Spokane, **Mahlon Hartley** lives in Staunton, Va., **Harry Witherow** is in Schenectady, N.Y., and I live a life of leisure in a suburb of Portland, Ore. My wife and I spend the winters in a trailer in Palm Springs. In the summer we travel the Northwest in our motor home visting lovely state parks on the coast, in mountains, or on the Columbia River. Then, in the fall we travel to see all the University of Oregon football games. I graduated from there in 1918."

Following receipt of **Harold Cake**'s letter, your secretary phoned and talked to **Harry Witherow** in Schenectady. I learned that there is no M.I.T. Club around here but with a large number of M.I.T. men in Schenectady, they have occasional meetings. Harry said he is feeling reasonably well, does little traveling, but still drives a car.

Quite a number of Christmas cards were received by your secretary and news items on those cards or letters will be covered in the next issue.

We have news from the Alumni Office of one death: **Decker G. McAllister** of Hillsborough, Calif., on July 29, 1984. Our sympathy is extended to his wife Martha.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 12203; **Josiah D. Crosby,** Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden,** Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA

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Our class president **Parke Appel** is still very active in the southwest Florida area. He is the photographer for the large Shriner Temple, where he takes dozens of pictures. He also sings in the church choir; is a sometimes lay reader; is active in the Telephone Pioneers; and (most importantly) is president of the Tech Club and liason man for the Alumni Association. . . . Just after Christmas, **Ab Johnson** came from Phoenix with daughter Joanne from Muncie to visit granddaughter Janet (Mrs. Peter Sharp) in Massachusetts. This prompted Buzz Burroughs, '20, to host a gathering of Ab's friends at the Winchester Country Club. Present were Ab's daughter Joanne, granddaughters Janet and Elizabeth, Mrs. Burroughs (Pat), **Buck Eacker**, **Bob Tonon**, and your secretary. There was considerable reminiscing about the SNTC fortified by Buzz's framed picture of the entire unit. Until word is received to the contrary, I think Bob Tonon qualifies as the oldest living active entrepreneur in our class, still running the Peter Gray Corp. and four other companies that he owns, all in Cambridge. Bob looks in the pink, kept so by running and tennis.

Madeline and **Lee Carroll** enjoyed a super trip last December to Grand Cayman which Lee says is "a still unspoiled (but going fast) isle with beautiful beaches." He says "I found out I could still bike, play tennis, swim, and snorkle! Damn lucky at my age and very thankful for same!" Lee and I ought to get together and play some of the tunes we knew so well during our years in the Banjo and Mandolin Clubs.

Word reaches me that **Don Carpenter** is slowly but steadily improving from his stroke of last April. We all wish him well. . . . **Frank Kurtz** has pretty well recovered from arthroscopic surgery on his right knee last summer which kept him using a walker for some time. He and Carlys became great granddparents last February. . . . Had a long letter from **Ed Merrill**. He and Vickie are now comfortably settled in their retirement quarters in Tulsa, and all is going well. A first great grandchild was expected last February.

Horace McCurdy and I are wondering how many might come to our 65th, only two years away. Since (as of this writing) only two of those at our 60th have passed away, we thought we might count on the rest and hope for others. Mac was able to spend 60 days aboard *Blue Peter* last summer, cruising much of the time in British Columbia waters.

Hicks Atwell, founder and retired owner of Atwell Claims Service Co. in Springfield, Mass., died last September at his home in Longmeadow at age 85. He is survived by his wife and a son Hicks, Jr. . . . **George T. Boli** died December 31, 1984 in Venice, Fla. at age 84. George, whom I remember well as the discus thrower of the 1919 track team, was a member of Theta Chi. He retired to Florida in the late 1950s. He is survived by his wife Maude. . . . A letter from Clara Silverman in January told me of the death on December 12, 1984, of her husband retired Colonel **Abraham George "Al" Silverman** at age 83 from a heart attack while on a Pacific cruise. Al had an outstanding career in the army. He received his commission in the Corps of Engineers in the early 1920s. During World War II, he was a supply officer in the Southwest Pacific theater. After two years in private industry, he was recalled to active duty in 1948, working at the Pentagon with the Army General Staff and the Defense Department Management Committee. He later served in West Germany. When he retired from active duty in 1957, he was stationed in New York. He then was a construction management engineer with the office of the Secretary of Defense until retiring a second time in the mid-1970s. His decorations included the Legion of Merit. He was buried in Arlington Cemetery with full military honors. . . . We extend our sympathy to the families of these classmates.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

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Al Pyle writes of a recent Mexican vacation. . . . **Charles Burke** reports that he is starting another four-year term as trustee of the Watertown Free Public Library, his 48th year. . . . **Gerald Fitzgerald** reports that he suffered a broken hip in January 1984, which was completely replaced a week later, but that nevertheless he still plans to chair our 65th reunion in 1988. . . . Owing to a slight stroke and consequent loss of some mobility your secretary/treasurer has resigned from the Alumni Council to make way for a more active member.

Ida and **Cecil Green** were guests of honor at a dinner at the Faculty Club marking the 20th anniversary of the dedication of the Cecil and Ida Green Building. Also, this year's Ida M. Green Fellows met with their benefactors recently when the Greens were in Cambridge attending a corporation meeting. The Green Fellowships, now in their 11th year, were endowed by a $1 million gift from Mr. and Mrs. Green and are used to support women who are beginning their graduate studies.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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The UnHoly Three, **Don Moore**, **Herb Stewart**, and **Russ Ambach** had lunch December 11 atop the Cambridge Hyatt Regency in its Spinnaker Room with its magnificent revolving view of the Charles River and its surrounding area. **Ray Lehrer** and **Dick Shea** are soaking up health-building sunshine in Florida, and **Don Fife** was busy on Cape Cod.

The item most discussed was the scientific honor achieved by **Don Moore**'s daughter, Professor Sandra Faber in Santa Cruz, Calif. A full-page photograph and astronomic accomplishments appeared in the December issue of *Science Digest*. She was one of eight astronomers and astrophysicists named from the "100 brightest young (aged 24 to 40) American scientists who have made discoveries that are changing the course of science" (selected by a board of scientists). Her interests have to do with galaxies and the connection with the early universe, a subject totally foreign to your amanuensis.

We are indebted to Ed McCaughlin, '25, for a Nyack, N.Y. newspaper obituary on **Francis E. Manley**. He died November 2, 1984 in Sarasota, Fla. Frank entered M.I.T. on a full scholarship and was awarded an S.B. in civil engineering. He began his career with the Rockland Light and Power Co. (New York) and in four years moved to Leominster, Mass. to accept the presidency of the Fitchburg Gas and Electric Light Co., from which he retired in 1970. He was very civic-minded and founded the Rockland Community College (New York) and was the first chairman of the board of trustees from 1959 to 1962. After moving to Sarasota Fla., in 1974, his Church sponsored the construction of Bay Village, which became a model for retirement home planning. He was president of the Nyack Rotary Club, director of the Nyack YMCA, Nanuet National Bank, a Fitchburg Bank, and the Fitchburg Chamber of Commerce, and a deacon in his church, and a Mason. Frank was known for his organizational skills.

We have learned from a Boston newspaper of the death of Rear Admiral **Alan Fisher**, following surgery, on October 7, 1984. He earned his S.M. degree following his graduation from the U.S. Naval Academy in 1922. He furthered his education at the Naval War College in 1943 as a student and staff member. Al held various engineering and marketing positions for 40 years while with GE's Warren Telechron Division, eventually developing equipment to maintain correct average frequency. After active service in the Pacific during World War II, he became a senior naval reserve officer for many years and was promoted to rear admiral in 1958.

Notes from two retirees: **Dave Kanter** reports that he has authored two primers—one for the study of Hebrew and one for the study of Yiddish. **Cam Ross** has retired from W.R. Grace after 55 years and celebrated his 50th wedding anniversary with Lois (Mt. Holyoke, '27) among children and grandchildren on Cape Cod.

Dick Shea has finally achieved the rank of "free-lance columnist" by generosity of his local Florida Sun City newspaper. The clippings that your scribe received were a sample of Dick's erudite philosophy and review of his little book, *Dancing Cheek to Cheek*, an electronic engineer's New England episodes from boyhood to senior maturity.

Request 60th reunion pictures and directory from your secretary.—Co-secretaries: **Russ Ambach**, 216 St. Paul St., Brookline, MA 02146; **Dick Shea**, 709 Cypress Pl., Sun City, FL 33570

25 60th Reunion

As the holiday season comes to a close, greetings from several classmates are acknowledged. **George "the Count" Blonsky** and Lotte write from San Jose, Calif. George left New York after

25 years, feeling that city would be the first place to be hit in case of war. He chose San Jose because all of his remaining relatives live in that area. He now feels this may not be a much safer place, with all the concentration of high technology in Silicon Valley plus the San Andreas fault. George says he is about 90 percent blind, but he does a good job of writing a legible letter. Lotte takes good care of him, and he gets to Palo Alto twice a week for lectures and senior citizen activities. . . . Adele and **Ed Kussmaul** sent greetings from their winter home in Briny Breezes, Boynton Beach, Fla. . . . **Kamy Kametani** continues to be a good correspondent. He tells us about the fine reception given to the Grays and the Goldbliths in Tokyo. Professor Hiroga Fujisaki, '59, president of the M.I.T. Association of Japan, presided at the meeting. He is professor of electrical engineering at Tokyo University.

After talks by the guests, Kamy was called upon to toast everybody's good health and happiness. . . . Elinor and **Sam Spiker** sent greetings. Sam is working on the 60th reunion gift and is assisting on plans. . . . Eleanor and **Fred Greer** report from Naples, Fla., where they continue to enjoy their retirement community. They spent two months in the North Carolina mountains last summer and hope to make our 60th reunion. . . . **Ben Oxnard** hopes to make the reunion. . . . **Frances Stanton** hopes to attend Technology Day next June and join some of the reunion activities on that day. . . . **Lil Drew** writes that she doesn't expect to come east until July 1985 and will likely miss the reunion.

Milt Saltzman got to the Cape around Christmas time and called on the Fosters with his son Roy, '55, and Roy's wife. They were back in this country from Brussels, Belgium. . . . **Russell Grove** writes from Marietta, Ga. that he is gradually reaching full retirement from his law practice.

It is with sorrow that the passing of **Francis Field** must be reported. He died July 8, 1984 at Ashville, N.C.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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After several months of sparse news, correspondence has picked up to a point which might exceed our limit, so we will carry over some of the news to a later issue. . . . A note from **Lester Hopton** advises of the method which he prefers to make his M.I.T. contributions in the future. . . . From **Dwight Woods**: "Clemmie and I are still active and trailering. We spent January and February at South Padre Island, with trips into Mexico by car. Then in July we visited the NRA rifle ranges at Raton N.M. On the way back we bought a new AVION trailer at Hobbs N.M. Got home, and I had a cataract operation and am now just getting back to where I can drive again. We are planning to go back to South Padre this coming January and February to meet with old friends." . . . From **Ted Taylor**: "Retired in 1969 from Western Electric as manager, international patent licensing." . . . A note from **Tom Green** states that he had missed the last few lines of our announcement of **Dave Shepard**'s passing, in which we mentioned contributions to M.I.T. in his memory. He then goes on: "So, in nick's time, for the still current year, I have just sent off a check for the fund to liven forever the memory of only the second man I knew with seven buttons on his vest, our beloved Dave Shepard.

I would hope that somehow the establishment of the fund may be emphasized a little more noticeably in another edition of your notes. Incidentally, I wrote Dave last spring with the suggestion that he might possibly be interested in a 'retirement community' being built here. He replied that he would stay put, and meant to leave there feet first. I wish I had known enough to go down and see him."

A few weeks ago we received our copy of the 1984 *Alumni Register* which lists names of the 100,000 M.I.T. alumni and the addresses and other information of those now living. A copy may be secured by ordering from the Alumni Association at a cost of $32.45.

A telephone call from **Rufus Briggs** at his Melrose home advised us of the recent death of **Ole Hovgaard** of Brunswick, Maine. Rufus told us of his retirement from GTE Sylvania years ago and his continued activities in community and church affairs since. . . . **Peter Bellaschi** sent us some technical information to pass on to John Mattill, editor-in-chief of the *Review*, concerning protection of high-voltage transmission lines. He also included a listing of precautions to be taken by individuals, which I thought might be of more general interest to all alumni, so I have forwarded that, also, rather than confining it only to our class notes.

Notice was received of the death of **George E. Rogers** of Lexington, Mass. on June 7, 1984. George had been a practicing attorney in Cambridge for over 50 years. He is survived by his daughter, Faith Rogers. . . . Another Alumni Association notice lists the death on November 3, of **Russell L. Houghton** of 161 West 16th St., New York, N.Y. 10011. The only survivor listed is his wife's niece, Ms. Sara Hall, of 331 Main St., Brockton, Mass. . . . An article in the Portland, Maine *Evening Express* advises of the death after a brief illness of **Elmer C. Warren** on October 11. Elmer had received his master's degree in education from Boston University in 1928 and taught physics at M.I.T. the following years. He taught mathematics for many years at Colby college and later was registrar and director of personnel at the college. He served in World War II from 1941 to 1945 at bases in Orlando, Fla. and Atlantic City, N.J. He was a member of the Colby Board of Overseers, a trustee of Thomas College, and an active member of several health associated societies. He is survived by his widow, Eleanor; two daughters, Barbara Reed of Reading, Mass. and Emily Taylor of Cumberland Center; and five grandchildren.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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Herbert G. Johnson is one of our still-active classmates, "consulting for some old clients and young inventors and manufacturers in the field of solid-phase forming of plastics and metals." It is no wonder, because Herb has accomplished so much in his lifetime as an engineer and inventor in the field of high-pressure molding known as "solid-state technology." His Johnson Engineering Co. started with the construction of a full-scale mechanical engineering laboratory with hydraulic and mechanical presses to 1300 tons capacity. He also developed an all-electric flashless forging system to produce finished parts—such as flanges and valve parts—without requiring machining.

Our sympathy is expressed to the widows and families of these classmates: **Gordon E. Thomas** died in September, 1984, in Natick, Mass. He spent 17 years with Metcalf and Eddy Consulting Engineers in Boston. After retiring in June, 1973, Gordon became too restless and that July joined Chas. T. Main, where he worked on what he had become an authority, water power engineering. . . . **Adelbert N. Billings** died on November 13, 1984, at his home in Richmond, Va., following a prolonged illness. Al spent 37 years with Kelly Springfield Tire Co., retiring in 1965 as an assistant development manager. He lived for a while in Cumberland, Md. He was a past president of the Allegany County Historical Society and enjoyed taking auto trips and searching for antiques. . . . **Leonard B. Riley** died on September 26, 1984, in Denver, Colo. He took up mining at M.I.T. and was president of the Mining Engineering Society, which started his lifetime career. His education continued with a Ph.D. from Yale. Len spent two summers in the copper mines of Butte as a mucker—the lowest position in the mining hierarchy—removing the waste rock from the blasting in the mine. He became a mining geologist—guiding the plans for mine working, determining the value of ore, and exploring for additional ore beds. After working on uranium for the Atomic Energy Commission Len joined U.S.G.S. in 1951 to establish laboratories in Denver. He was a leader in a diverse group and was a source of inspiration and guidance to those working with him. They depended on the results of the laboratory for their own work. He sensed the need for the use of statistics and computer methods in geological studies.. He retired from U.S.G.S. in 1975. A loving family man, the memory of his influence on his associate's lives will continue.

These notes are the first that your secretary has prepared on his I.B.M. P.C. Jr. computer. He is, at last, entering the computer age.—**Joseph C. Burley**, Secretary, Box 416, RFD #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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This column is being written in early January and following the holidays, so that it is now that we thank all of you for the many welcome greeting cards and notes that were sent to us. The year end, as usual, has produced a flurry of miscellaneous news items and they mostly are the basis of this issue of classnotes.

Hal Curtis writes that he has been happily married for 54 years and is in good health. He and Edith have two daughters, three granddaughters, and two grandsons. The older two granddaughters are now at Harvard, the alma mater of both daughters and their husbands. Following retirement in 1966, Hal spent about one and one-half years traveling in Europe. The Curtises spend about three months each year in Maine, the rest of the time in New Jersey. Hal keeps busy with his many hobbies. . . . Gracia and **Tom Harvey** had a good year. On February 14, 1984 they gave each other a beautiful Chevrolet Impala sedan as a Valentine present. In October they took another of their Mississippi River steamboat trips, this time on the *Mississippi Queen*, a much newer boat than the *Delta Queen* which they have enjoyed in past years. they stopped for a daytime visit at Galena, Ill. where Gracia's distinguished kinsman, President Ulysses S. Grant, once lived. The old Grant home is now an historical landmark.

George Mangurian tells us: "We made our fifth home exchange in September, this time in South France for three weeks. We were close to St. Raphael so visited many cities and towns along the coast as well as Avignon, Nimes, Arles, and Aix-en-Provence. We had good weather, good and bad food, but good wine." . . . A year end letter from Betty and **Dud Smith** tells us how they spent their year. The highlight experience was a 23-day Mexican-Yucatan rail tour. They had a drawing room on a private train with lounge and dining car facilities. The food was excellent. With many interesting sights and places to enjoy and with occasional overnight hotel stops, the 9,340-mile trip proved not too demanding and was praised as a great experience.

Anne and **George Palo** spent the holidays at home in Knoxville but had enough plans laid to keep them very busy well into the new year. . . . Ann and **Will Tibbetts** were in Cambridge for 1984 Technology Day, then left shortly thereafter for Europe. They spent a month in Germany and Austria visiting with friends then went on to the Italian Dolomites. For the rest of the summer they were at their camp in New Hampshire.

A letter from **Morey Klegerman** to **Jim Donovan** brought the sad news that Morey's wife, Claudia, had died of cancer on October 19, 1984. It was a long and difficult illness. To Morey and his family we can only offer our deepest sympathy.

With regret we must report that **LeRoy H.**

Nothdurft died November 15, 1983. LeRoy received his S.M. degree in electrical engineering with our class. He went on to earn his M.B.A. at New York University. His profesional career was in electrical engineering spanning long association with each of six major companies. His civic services included effective participation on educational boards and committees and in church activities. To wife Emma, their two daughters and their families we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Edward C. Roche of Buffalo, N.Y. writes, "Sorry we had to miss the 55th reunion, but we attended our oldest grandson's graduating exercises, he received his B.S. in chemical engineering from New Jersey Institute of Technology. My wife Dorothy and I enjoy relative good health and stay active. We are going to Washington, D.C. to spend Christmas holidays with our daughter and her family. Our best wishes for the new year to all our friends." . . . The National Aeronautical Association of Washington, D.C. elected **J. Russell Clark**, our class president, "Elder Statesman of Aviation." In mid-October, he and his wife Dot attended the National Alumni Conference, which was held in Dallas this year. He writes, "The Institute staff did a superb job. Dot and I really enjoyed our 55th at Cape Cod and the M.I.T. campus. We are now counting down for the 60th. Dot and I just returned from a trip to Colorado and New Mexico —beautiful mountains and fabulous sceneries, snow at 9,000 feet, golden aspens among the green forest trees. It rivals New England scenery in its own way. We drove through a snow-storm on September 28, from Leadville (10,500 feet to Lake Dillon (7,000 feet). Best wishes to all." . . . **Edward R. Godfrey** of Huntington, N.Y. writes, "Had our usual Caribbean trip last winter. My wife's vision has improved greatly after two implants for cataracts. As for me, I have no complaints, except creeping old age which has slowed me down." . . . **Adrian N. Clark** of Woodbury, Conn. writes, "I am still active, and sing in the North Congregational Church Choir. On the golf course, I break 100 now and then. I also drive regularly for local volunteer groups to hospitals and local and state agencies. No complaints." . . . A card from **John D. McCaskey** of St. Joseph, Mo. reads, "Thanks for keeping us up to date on our Class of 1929 members. A happy new year to all."

Barbara and **George J. Meyers** send their annual greetings with a summary of 1984 activities. Barbara had her 50th Radcliffe reunion last June, while George had his 55th with us at M.I.T. Barbara has been very active in Episcopal Church Women, Companions of the Holy Cross, and the International Order of St. Luke. George thought he had retired, but did some consulting from the Glen Gerry Co. He is also involved in the Order of St. Luke and is guiding nine Girl Scouts through their "God and Country" program. . . . Elise (Mrs. **Warren) Walker** sends news. Warren is proud to report a banner year in sales and profit for Graphite (his company), under the shared leadership of Warren, son-in-law John Michelsen, and son Eben. The Presby Iris Gardens in Montclair, with which the Walkers have been active for many years, are becoming a real tourist attraction. Because of Warren's contributions to it, one of the iris beds is being named in his honor. The Walkers welcomed the arrival of their tenth grandchild, Colin Warren Walker, in April.

I regret to announce the death of **John P. Rich** of Nashua, N.H. on November 21. **Bill Baumrucker** reports that John had been sick (cancer) for quite a while. "He was a good friend and a loyal member of the Class of 1929," says Bill. John was associated with Improved Machinery, Inc. (now Ingersoll-Rand Co.) for 40 years, retiring in 1971 as its president. Since retirement, he acted as business consultant for Para-Legal Engineering Consultants, Olympic Refineries, Inc., Nashua Wood Products, Inc., Gemcor Co. of Buffalo, N.Y., and Surftech Corp. John also acted as trustee of Rivier College, the Anctil Foundation, Nashua Memorial Hospital, and numerous other private trusts. He was past president of the Nashua Country Club, the Twentieth Associates Investment and secretary of our class until 1969. He had authored a number of publications in pulp and paper technologies and was inventor and holder of 32 patents in the U.S., Canada, and Sweden. He is survived by his wife Olive and two sons.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

30 55th Reunion

In the spring of 1983, **Wally Hope** gently chided me concerning the lack of news about his Course XIV classmates. I assured him that I had no bias against electrochemists, but can put in the Notes only such information as is supplied to me. He agreed to help me out by writing to his coursemates, and his efforts have now elicited responses. According to Wally, there are only four surviving electrochemists; as items about Wally and **George Temple** have previously appeared, this issue completes the report: Upon graduation, **Dick Hartwell** worked briefly for Waltham Watch and then returned to M.I.T. on a research project in the Division of Industrial Cooperation sponsored by American Can. When this project ended he accepted from the sponsor a job that lasted until his retirement. He was initially located in San Francisco but spent most of his career in the Chicago area. His work for American Can was focused largely on a long-term, in-depth study of the factors causing corrosion of tinplate. He compares this research program to peeling an onion: Each time he identified a corrosive factor and found a way of controlling it, another problem would appear. In 1957, his expertise in this field took him to Italy to deliver a paper to a technical group in Rome. After his retirement he signed up with the International Executive Service Corps, and he and his wife, Kay, spent three months in the Philippines helping a tinplate producer in the Manila area. The Hartwells now live in Oak Park, Il. . . . Most of **Leslie Guilford**'s career was with the Navy Department. He worked initially as a metalurgist at the Bureau of Ships in Washington, D.C. After about ten years he took advantage of an opportunity to retrain as an electronic engineer and was assigned to the Sonar Branch of the Anti-Submarine Warfare Division. At the time of his retirement, he was head of the Anti-Submarine Warfare Technical Section in the Office of the Chief of Naval Operations. He and his wife Lillian now live in Kensington, Md.

Three more notices have come in concerning the deaths of classmates: **Harold Baker** died on September 18, 1984. After graduating in course IX-B with a B.S. and M.S. from M.I.T., Harold did graduate work in education at Harvard and then taught engineering at the University of Pittsburgh for a number of years. He later worked on the Apollo space program for Gruman Corp. in New York and on the west coast. After his retirement he settled in Aptos, Calif., where he was active in community affairs as a founder of the local Democratic Club, president of the Unitarian Fellowship, an active member of the Santa Cruz county Art Museum, and a photographer whose portfolio had, shortly before his death, been accepted for admission to an Ansel Adams Workshop. He is survived by his wife, Elizabeth, two sons, and a daughter. . . . **Norman Dolloff** died on October 3, 1984. After graduting from M.I.T. in Course XII and acquiring a master's degree at Columbia and a doctorate in metallurgy at Stanford, he taught geology for many years at San Jose State. During the 1960s he was chairman of the S.J.S. geology department, but he preferred classroom teaching, which he continued on a part-time basis after his retirement in 1978. He was involved in numerous extra-curricular activities: he was an earthquake expert who gave lectures on the causes of earthquakes to scientific societies and community groups in the Bay Area; he invented a chemical dissolution process for recovering copper from underground ore bodies, which was technically operative but turned out to be uneconomic; he served as chairman of the Los Gatos school board, of the Santa Clara County School Redistricting Committee, and of the local chapter of the American Association of University Professors; and he served as president of the Santa Clara Tuberculosis and Health Association. Norm's wife, Phyllis, and son, David, survive him. . . . **Harry Fekas** died on November 2, 1984. He spent his career as a civilian engineer in government service. Early in his career he worked for the New York City Board of Transportation on design and operation of the then-new Independent subway. Thereafter he worked as an electrical engineer at the Tactical Air Command, Langley Air Force Base, Hampton, Va. For about three years he was assigned to an airbase in the Canal Zone, which gave him an opportunity to travel in South and Central America. After his retirement in 1975, he did consulting work for Spiess and Waltz. He is survived by his wife Athene, two daughters, a son, and seven grandchildren.

When you read this, the 55th Reunion will be almost upon us. As of mid-November, we had 20 firm "yesses" and about 40 "maybes." It is now time for the "maybes" to make a definite commitment to attend. To refresh your recollection, the place is the Colonial Hilton in suburban Lynnfield, Mass., and the time is June 8-11.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 85614

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From West Texas we have belated news that **Norman D. FitzGerald** and his wife, Brownie, have celebrated their 50th wedding anniversary, and by the time this is in print, their 51st. Dr. FitzGerald writes, "The celebration was inspired by our three sons, Norman Scott of Houston (University of Texas, '62), a CPA and independent businessman; Dr. Carl Hanson, '63, senior professor of mathematics at the University of California in San Diego; and Gerald Texas (Trinity University, '73) a geologist and geophysicist working for one of his father's enterprises, the Norman Oil Corp. Each month I read the class notes with great interest for news of our friends and finally realized that I had an obligation to supply some myself. There is no way to overlook the passage of time, but we are fortunate to be able to reflect on the fact that in addition to the normal problems, we have participated in a lot of interesting and truly fascinating events. Among them was the 50th Reunion of our Class on Martha's Vineyard; we look with anticipation to the 55th." . . . Charlotte and **Ed Hubbard** write, "Recently we attended Polly and **Ken Germeshausan**'s 50th wedding anniversary party, which was lovely. The **Buchanans** (who spent the night with us) and the **Richardsons** were present. At a Boston Symphony concert we bumped into Clare and **Ben Stevenson**, so the next time we all enjoyed lunch together. Great fun! Ed is very busy establishing his business, so not much time for M.I.T."

A sad Christmas note tells of **Emile Grenier**'s death. A newspaper clipping reports, "Emile P. Grenier, an Ann Arbor engineer who spent more than a decade of his retirement years working on automobile safety programs and community projects, died of cancer at the Glacier Hills Nursing Care Unit. He would have been 74 on December 23. Grenier's field of concerns embraced a multitude of subjects, but since his retirement twelve years ago from the Ford Motor Co., much of his energy was spent on automotive safety. He spent more than five years fighting the proposed airbags for new cars. As a Ford engineer, Grenier had supervised the first tests of the airbag and was convinced from the beginning that the bags

were an impractical answer in injury prevention in car crashes." His wife adds, "I kept hoping he would hang on, but I'm afraid it was for me, not him. He was having so much pain. About the last week the sedation had to be increased considerably and I think finally his heart could take no more. The last couple of days, fluids were building up, with labored breathing and swollen hands. He tried valiantly to fight the tumors but it was just impossible."

Assistant secretary **John Swanton** received notice from the International Association for Earthquake Engineering of the death of **John Kazuo Minami** at the hospital of Japan Medical University, Tokyo, on May 17, 1984, after four months in the hospital. He had been engaged in research and teaching at the School of Science and Engineering, Waseda University, for 34 years until his retirement in 1978, on which occasion he was awarded the title of professor emeritus. As the first secretary general of the International Association for Earthquake Engineering, he played a prominent role in establishing the Association. As a UNESCO expert, he visited Chile and Libya in the early 1960s to assist in promoting seismic construction of building structures in those countries. In 1950, he was awarded the scientific medal of Architectural Institute of Japan for papers on shell foundations. The implications of the research, lasting from 1968 to 1978, on the earthquake response of soil-foundation-building systems have been widely recognized for the seismic design of building structures. It was a shock to learn of John's death. During my visits to Tokyo, I used to have him and his wife in for dinner almost every trip. In turn, John frequently took me out to dinner at various Japanese restaurants.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **Ben W. Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158

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We have received word through **Rolf Morral** that **Juan Serrallach** died on November 25, 1984, comforted by the holy sacraments and apostolic blessing. Juan was popular and well known by many of his classmates. He lived an active and varied life, but the last few years he went back to his Spanish wife and children in Barcelona and they took good care of him.

Lillie and **Rolf Morral** have been celebrating their 50th wedding anniversary throughout 1984. They traveled widely throughout Europe. The rest of the time they were writing, reading, bicycling, walking, partying, visiting, and Scrabbling. They find watching their grandchildren grow even more interesting than metallurgy.

John A. Finnerty is our own class agent and **Gaynor H. Langsdorf** is our class estate secretary. The M.I.T. Alumni Fund report lists 324 active alumni in the class of 1932; 57 percent (186) are donors to the Alumni Fund. This compares well with other classes.

Sustaining Fellows and Life Members (total contributions over $25,000) are: **Bennett Archambault, Mr. and Mrs. Wendall E. Bearce, Cecil Boling, Donald W. Brookfield, Mr. and Mrs. Howard F. Carver, Mr. and Mrs. Alexander D. Daunis, Byron E. James, Gaynor H. Langsdorf, John Navas, Mr. and Mrs. Eric P. Newman, Robert B. Semple, Mr. and Mrs. Richard M. Stewart,** and **Mrs. Carroll L. Wilson**.

Sustaining Fellows and Annual Members are: **John J. Brown, Dr. and Mrs. Rolf Eliassen, George K. Kerisher,** and **Albert J. O'Neill**.

Great Dome Associates are: **Edward F. Cahoon, Melvin Castleman, Timothy P. Coffey, Irving Kalikow, William A. Kirkpatrick, Eugene F. Lynch, Jacob Millman, Willis M. Moore, Jr., Robert K. Mueller, Archie Riskin, James G. Ritchey, Thomas R. Smith, Charles H. Taylor,** and **Thomas Weston**.

Ed "Bunny" Nealand has lost his 1932 class ring (with the beaver). He sorely misses it and has searched high and low for it. He has finally given up hope of finding it. If there is any classmate or spouse that has such a ring and is not using it, please let Ed know, as he would like very much to buy the ring.

We have received the sad news that **E. Allen Newcomb,** 74, died September 14, 1984. Prior to his retirement, he was president of the Malmstrom Chemical Co. of Linden, N.J. He is survived by three daughters, ten grandchildren, and five great grandchildren.

We have also learnt that **Lucien B. Curtis** died in 1984. When we get some obituary information we will pass it on.

By the time you read this, our class mini-reunion on February 14 and 15 at Hyatt Sarasota Hotel will have taken place. The plans sound excellent and I am sorry that I cannot attend. I am looking forward to a good report from **Don Brookfield**.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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A "lost sheep" showed up with the Christmas cards: **John Mesker**, a construction department man came through for the first time since graduation. He's the one who sent a steel window to one of our early class reunions for a draw prize. Who won it? Do you remember? John and Nina spend the winters on their boat in south Florida and travel extensively in other months.

Our great loss is the death of **George Henning**, who died late last fall. George and Lucy attended most of our class reunions, and he served the class in many capacities. . . . **Frederick H. Cooper**, who lived in Dallas, passed away last year. . . . **Herbert Breitstein** died last fall.

Ellie and **Mal Mayer** traveled in Britain. . . . Anne and **Fred Murphy** were on the West Coast with the **George Stolls**. . . . How about this? The **Allan Hinkles** went on an M.I.T. Quarter Century outing and found the **Donald Neils**. Don was one of our contractor members after graduating from West Point. Both families report a wonderful trip and recommend it.

Dave Nason, via the Alumni Fund, sends a one line report: "After a honeymoon in Scandinavia, we are enjoying life in Houston." . . . **Clarence Westaway** included in his Christmas card word that he is better again after a spell of sickness last fall. . . . **Prentiss Huddleston**, Tallahassee, Fla. says he retired a year ago and is now an architectural specification consultant. . . . **Emerson S. Norris**, who lives in New Castle, N.H., tells us of a good recovery from strokes in 1975 and 1982. He gets around with a walker now.

Ellery Clark says they saw **Gus Liljergren** in Washington state last summer. Gus doesn't believe in retirements. . . . **Neil Hopkins** gets about on his 15-speed bicycle in York, Pa. The Clarks attend Elderhostels and plan a travel trailer trip to Baja, Calif. this year. . . . **Bill Kilbourne** restores old cars in Waltham, Mass. . . . **Clarence W. Farr**, Greenfield, N.H., writes that he and Aline saw Velma and **Bob Smith** in Glen Falls, N.Y. Both Smiths have had heart surgery and are doing well. Bob drummed with the Techtonians, and Clarence says his fingers are still in demand for the piano at community events. **Donald Newhall**, through his Harwood Engineering Co. in Walpole, Mass., makes high pressure equipment—200,000 pounds regularly and to a million pounds per square inch for research. . . . **Cooper Cotton** writes that he takes care of the golfing in Columbia, Mo. and is ready for spring to come in full force. . . . Marg and **Bob Crane** were back in Florida for the winter. He's a consultant to a firm of architects. They will be back on Cape Cod before too long now. . . . **Bill Huston** gets about—to Switzerland and Austria in the past 12 months. . . . I had a pleasant chat with **Dick Fossett**. All goes well in California.

Jim Turner has beeen feeling poorly in Florida this winter. . . . **Leonard Julian** notes that his family is busy everywhere—and there are a lot of them. He writes like a typical grandfather. . . . Doris Julian was in Bermuda shortly after Christmas with her sisters there. . . . Let your classmates hear from you through your secretary.—**Beaumert Whitton**, Secretary, Sharon Towers, Cottage 112, 5150 Sharon Rd., Charlotte, NC 28210

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The "good news" items outnumber the "bad news" items this month by 3:1, so let's take the latter first. . . . Through the Alumni Fund drive we received feedback on another loss; this time it is **William Kraybill** of Albuquerque, New Mexico. He died October 17, 1984, but beyond this I have no information. There is also no word about surviving family, but if they get to see these notes I hope they will accept condolences on behalf of all the class.

There are three Alumni Fund notes, fortunately. One, from **Ernie Massa**, says "I enjoyed seeing my former classmates—some I last saw in the great halls of M.I.T. 50 years ago! My wife Jeannette and I are planning to attend the 51st in 1985." (That's the mini being planned for Williamsburg in September.)

The other two are from people who apparently enjoy traveling the way I do. **George Bull** writes, "Mary Elizabeth and I have just returned from a 16-day trip to Europe. The main feature was five days on the Rhine from Rotterdam to Basel, with the impressive eight locks to lift the ship up from Strasburg to Basel. Also visited St. Francis' Assissi." Our other traveler is **Gil Lorenz** who says, "Spent three weeks in July visiting our daughter and family in Denver and the month of September in Europe seeing Oberamagau, Salzburg, Vienna, and taking a countryside tour of France; through Normandy, the Loire Valley, and Burgundy."

As these notes are written (January) the Cape has finally gotten the 6-inch snowfall that forecasters have been promising for about a week. All this enhances the fact that in two days I'm off for my annual escape from New England winter by going to Barbados for a week.—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35 50th Reunion

The 50th reunion committee met at the M.I.T. Faculty Club on December 13 to plan for the last mailing to go to our classmates in January. In attendance were **Goffe Benson, Prescott Smith, Nix Dangel, Hank King, Bernie Nelson,** and Joe Martori from M.I.T. This last mailing includes information for reservations, etc. The deadline for reservations is *April 1*. If you have not yet replied, contact Bernie Nelson or me immediately, and we will see what arrangements can be made to accomodate you. The returns from the committee's earlier request so far indicate that 74 classmates (with 5 part-time) will be at M.I.T. With spouses and friends, the total is 131. Sixty-one classmates indicate attendance at Wianno Club (with two part-time). With spouses and friends, the total is 114. Twenty-nine classmates asked to be kept posted.

In 1961 the **William L. Abramowitz** Fund was established at M.I.T. as a memorial to Bill. The 1984 Abramowitz Memorial Concert was held at Kresge Auditorium last October 27, where they presented the Eric Hawkins Dance Co. He is known as one of the pioneeer revolutionaries of modern dance. . . . H.R. Spaans, '30, sent me a note with the obituary of **George R. Bull**, who died suddenly at his home on December 9. They had both worked at the Bell Co. of Pennsylvania and in the stage crew of the Highlighters Theatre in Berwyn, Pa. George was a close friend of **Ber-**

nie Nelson, first in Course I and later while working together at New York Telephone Co. in Buffalo in 1935. George had been looking forward to our 50th, and we shall miss him.—**Allan Q. Mowatt**, Secretary, 64 Boardman St., Newburyport, MA 01950

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As these notes are due early in the new year, it is pleasant to have many greetings to share with you. First however, I'll give you the sad news. **Stephen H. Richardson** died in early December in Seattle, after a brief illness. His architecture firm, TRA, designed many large buildings including some at the University of Washington, Sea-Tac Airport, Children's Orthopedic Hospital, and People's National Bank, as well as the award winning Gaffney's Lake Wilderness Lodge. A scholarship in his name has been established at the University of Washington's college of Architecture and Urban Planning, from which he was graduated before coming to M.I.T. He is survived by his wife, Mary, a daughter, and four grandchildren. . . . **Bernard Schulman** died last May 14 after a six-month bout with a brain tumor. For many years Bernie was president of the Akron Towel Supply Co., and after retiring some 18 years ago he and Sylvia moved to Florida. They had traveled extensively and acquired an art collection, one of their greatest interests. For several years he was president of the Akron Art Institute. He enjoyed living in Florida, and worked in commercial real estate there. He is survived by a son, a daughter, and his wife, Sylvia, whose address is 2850 N. Palm Aire Dr., Pompano Beach, FL 33060. . . . **William Fingerle, Jr.** died of kidney cancer at his home in Old Greenwich on December 6. Since graduation he had pioneered in two-way radio, installing many police radio systems throughout New England. He designed and built the first television transmitter for Allan B. DuMont's Channel 5. In 1951 with a friend he started a business designing and manufacturing telephone carrier and microwave communications systems. Leaving that business to others, he spent a year (1964) traveling with his family around the world. He then worked with another friend creating machinery for recording tape cassettes, from which he retired a year ago. He had planned to work in his basement workshop where he had already made a guitar and a harpsichord and created and repaired all manner of "things" large and small for his family, friends, and the First Congregational Church of Old Greenwich. He sang in the church choir and with the Greenwich Choral Society and played tournament bridge, being a life master. He is survived by his wife, Martha, a son, and a daughter. His home address: 35 Midbrook Lane, Old Greenwich, CT 06870. I talked with both Sylvia Schulman and Martha Fingerle and extended sympathy in the name of the class.

Gleanings from the holiday messages: Vivienne and **Eli Grossman** have traveled some, gardened some, and played tennis with, so they say, no improvement. Eli does a bit of consulting also. . . . Dottie and **Tony Hittl** have also been traveling—to Southeast Asia and India, to New Orleans, and to Alaska aboard the *Pacific Princess*. About as you read this, they plan to visit Tony's daughter in Austria. . . . Bernardette and **Roman Ortynsky** visited the Grand Canyon just a year ago and found it beautiful but cold. (Undoubtedly colder than Peachtree City, Ga!) . . . As usual, Ruth and **Hank Lippitt** have spent time in Switzerland, Ruth's native land, and in addition have visited the Pacific Northwest and in California, the Death Valley area. Hank kept his nose on the grindstone while Ruth went off to South Africa.

Your secretary did her own bit of traveling—a week on a houseboat on Lake Powell in March after camping her way across Louisiana, Texas, and southern New Mexico. In June, I spent a week at Colter Bay in Grand Teton National Park at a spectacular Hunter family reunion. It was the first time in nearly 12 years that my four offspring and I were all together. In September, I spent ten days exploring Cape Cod. My daughter Martha and I are planning a week in Texas at Big Bend (maybe) in March and I will be back home for the next reunion planning meeting on April 16. Remember, your comments are solicited!—**Alice H. Kimball**, Secretary, P.O. Box 31, W. Hartland, CT 06091

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Stanley D. Zemansky of Paradise, Calif., retired purchasing agent for the city of Baltimore, Md., was awarded the Albert H. Hall Memorial Award for purchasing excellence by the National Institute of Governmental Purchasing (NIGP) at its 39th annual conference in Baltimore, August 1984. This is the highest award that can be bestowed by NIGP. Stanley and his wife (also an M.I.T. graduate), now reside in California. . . . **George DeArment** of Meadville, Pa. retired January 1, 1981 as president of Channellock Inc. and serves as co-chairman of Channellock with brother Bill. George was awarded the Alumni Award, Allegheny College; Community Service Award, United Way; and the Service Recognition Award, Meadville Recreation Authority. His hobbies are golf, needlepoint, and stamp collecting. His wife's main interests are Hospital Red Cross Blood Donor Program and Garden Club. He is a director of the Alltel of Pennsylvania and was retired from Northwest Bank (now Mellon North) after 32 years of service. He and his wife Janet spend winters in Jupiter, Fla., (305)746-1489.

Ed Corea of Hingham, Mass. retired in 1975 from U.S. Navy Claims Investigation, NAVSHIP. In retirement he is working as a volunteer for the Hingham Energy Committee. He received a citation for his work from the Massachusetts Department of Elder affairs. His hobbies are bowling and coordinating RSVP (Retired Senior Volunteer Programs) volunteers at nursing homes, as well as being a board member of South Shore Elder Services, Inc. Ed took a two-week trip visiting sisters in Ocola, Fla., EPCOT, and Silver Springs, Md. Wife Marie's main interest is rug braiding. They have seven children—Virginia, Elizabeth, Gena, Ed Jr., Rosemary, Terry, and Katy, and ten grandchildren. Ed writes, "Time since retiring has passed rapidly. For a few years I did a little consulting for the navy. I am now doing volunteering. We spent a couple of months visiting one daughter in Germany and other month in Italy."

Henry Blackstone has moved from chairman and president to chairman of Servo Corp., Hicksville, N.Y.—**Lester M. Klashman,** Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, MA 02155

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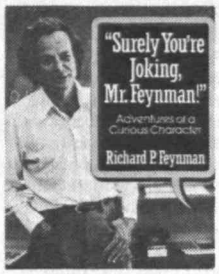
It'll be April when you read this, but I am writing this in January while the snow is coming down outside (snow on Cape Cod?). All of which leads us to **Bill Whitmore**. Bill reports that he is retired, but is working half time for Lockheed Advanced Marine Systems, and that his oldest son Charles had his first novel published: *Winter's Daughter*.

Ascher Shapiro, Institute professor of mechanical engineering, delivered the annual Jacob P. Den Hartog Award Lecture since he was the recipient of the Den Hartog Distinguished Educator award for 1984.

Sandy and I attended the M.I.T. Club of Cape Cod Christmas party, also attended by Roberta and **Horace Homer**, Phyl and **Don Severance**, Nancy and **Dave Wadleigh**, and Virginia and **Dick Henderson**. A good time was had by all.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633



A Nobel for a Noble Character

"When I was a student at M.I.T. I was interested only in science; I was no good at anything else," writes Richard Feynman, '39, in his autobiography, *"Surely You're Joking, Mr. Feynman!"* (W. W. Norton & Co.). Somehow he managed to turn most of his humanities requirements into science adventures. However, it soon becomes clear from the series of vignettes in his book that Feynman was good at many things.

In addition to winning the Nobel Prize in physics in 1965, he cracked safes at Los Alamos during the development of the atomic bomb and played in a samba band in Brazil in 1951. Albert Hibbs, a former student, most remembers Feynman for his love of physics. His joy was contagious, says Hibbs.

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Barry Graham wrote from Toronto that he is looking forward to a trip during 1985 to the Pacific Northwest to renew Alcan friendships and, hopefully, visit the **Bebies**, **Withingtons**, **Bartons**, **Alexanders**, and others who may be there then. . . . Mary and **Jim Barton** enjoyed an autumn motor trip in France and returned to their beautiful Lake Washington home to find Christmas greetings from Jean and **Sid Silber**, who expect to travel from Baltimore to the Northwest this summer. . . . Anita and **Bill Wingard**, also from Baltimore, wrote that they see dawn regularly as they prepare for new achievings at Bill's machine works. Some years ago a highlight for Hilda and me was being invited for an overnight with the Wingards. Our extra special treat was to taste Bill's personally prepared breakfast, built on his scrambled eggs sprinkled with homegrown chives. Very great!

Hans Bebie retired from Boeing three years ago. He and Austie ski and sail, smoke salmon, and Austie also paints with oils. Hilda and I visited their summer home, newly built and located at Seabeck, Wash. From their all-glass front, the view overlooks miles of saltwater expanse to the north, with the towering Olympic Mountain peaks (6,800 foot elevation) 15 miles to the west. At his high bank seafront, Hans built a dinghy-davit device based on the arm-strong principle. When he lowers his dinghy (to set his crab pots), the device works easily and well, especially if husky guests serve as "sidewalk superintendents."

Dora and **Paul Stanton** visited in Paris before Christmas and they relayed **Gordon Pope**'s generous invitation to use his Puerto Rico home for a mini-reunion. Interested classmates can write Paul at P.O. Box 642, Falmouth, Ma. 02541 or **Seymour Sheinkopf**, 205 Wolcott Rd., Chestnut Hill, Ma 02167. Also, Paul encourages '39ers who are alumni of Boston Latin School to attend their 50th reunion this summer. . . . Connie and **Manning Morrill** sent Merry Christmas greetings on a card bearing their pictures astride horses on a merry-go-round carrousel. The picture was just right and brought back happy memories. . . .

Linda and **Warren Evans** have a 31-foot auto home and enjoy caravan travel. In between travels, Warren consults for AARP and SAGE.

Latimer MacMillan retired as colonel from the military to consult. He became president of the PM Mining Corp. of Arizona, where he now can receive inquiries from classmates who want gold nuggets. . . . **Ruth B. Pitt** is associate professor at the University of Rochester in its Graduate School of Education and Human Development. Ruth wrote, with modesty, to say her research concerns the development of problem-solving abilities from adolescence to adulthood (including older science professors). . . . **William Davies** retired from the U.S. Geological Survey in 1983 after 35 years' service in Greenland, Antarctica, Australia, Indonesia, and Alaska.

George Hulst retired to Bradenton, Fla. after his 40-year career as electronics engineer, specializing in radio receivers, radio navigation, television receivers, radiolocation, communication systems, and electronic instrumentation. Now George sings in a Barbershop Quartet that entertains. George, please know that **John Alexander** and I also were members of the SPEBSQSA, and we harmoniously send you a chord-ringing B-flat-seventh. . . . **Burt Rudnick** continues activities in his real estate business and says he is amazed at how many of his classmates have completely retired. Burt, some of these competely-retired classmates find themselves busier now than when they were working for a living!—**Hal Seykota**, Secretary, 1415 Seacliff Dr., N.W., Gig Harbor, WA 98335

40 45th Reunion

An interesting news clipping from the *Wilton* (Conn.) *Bulletin* covered **John Bech**'s activities with his family in politics. He is a confirmed, articulate Republican father, while his youngest son, John Jr., who lives in the same town, is a confirmed, articulate Democrat, both so strongly committed that they serve on their respective town committees. They can argue while respecting each other's view points, and it is obvious they admire and like each other. John Sr., is president of his own company, Publication Services, in Stamford. They do ads, promotion pieces, and manuals for such clients as General Data Co. and Elinco, addressing a technical audience.

W. Kenneth Davis, independent consultant, affiliated with Bechtel Power Corp., San Francisco, has been elected a vice-chairman of the International Executive Council (IEC) of the World Energy Conference for a three-year term. The IEC, which met recently in Algiers, is the governing body of the World Energy Conference. He is also chairman of the member committee of the U.S. World Energy Conference, having been active in the World Energy Conference for nearly 30 years.

Amos E. Joel, Jr., switching consultant at AT&T Bell Laboratories, was recently awarded the 1984 Columbian Medal from the city of Genoa, Italy, The award was presented to Joel for his work in telecommunications switching in the U.S. and for his role in the study and planning of the world's first system using stored program control.

Joel joined the Bell Laboratories in 1940 and has been involved in telephone switching systems, including automatic message accounting equipment to automate telephone billing, and in fundamental engineering studies of new electronic switching systems (ESS) in which he was a pioneer. He holds more than 69 patents for his work, among them the longest U.S. patent ever issued, and is the recipient of numerous awards, including the prestigious International Telecommunications Union (ITU) Centenary prize. . . . A brief note to the Alumni Association from **Bill Steber** indicated that he retired in January 1984. He and his wife are living at 213 Harris Dr., State College, Pa.

Sad news to report on the death of **Michael E. Scalia, Sr.**, who died on November 10, 1984 while visiting relatives in Baltimore. Michael, who lived in Nahant, Mass. has worked for General Electric Co. in Lynn as an aerodynamics engineer until his retirement in 1982. He is survived by his wife, Flora, and four sons. **Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030

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Robert M. Fano retired from the M.I.T. faculty in June 1984. . . . **George Farnell** died September 2, 1984. He lived in Syracuse, N.Y. His wife Ruth survives him. . . . **Kenneth A. Roe** has received the Hoover Medal at the ASME annual winter meeting in New Orleans. The medal was established in 1929 for humanitarian achievements by engineers. . . . **Bjorn Lund** died September 12, 1984 at Waterford, Conn. He was born in Oslo, Norway in 1919 and attended the Berlin Technical Institute before coming to M.I.T. He worked for Allis Chalmers in Milwaukee, where he designed centrifugal compressors, which were a key factor for the success of the Oak Ridge Separation Plant of the Manhattan Project. Bjorn joined Electric Boat in 1954, where he first served as a Chief Engineer for the Skate's nuclear plant project. The Skate was the first U.S. nuclear submarine to surface through the ice cap of the North Pole. In 1965, he was project manager for the design of the nuclear power plant and systems for the Deep Diving Research Submarine, NR-1. He later managed a new deep submergence laboratory. In 1971 he became program manager for the direction, design, and manufacture of antenna ring mechanisms for the Fixed Acoustical Range, a major, international, undersea acoustical installation. All his life Bjorn was a prolific inventor and was honored as a fellow of the American Society of Mechanical Engineers. He is survived by his wife, Gunvor Anderson, and his mother, Margarte Ruud Lund.

Robert S. Edwards will retire at the end of December 1984, after 24 years with Sperry. The last ten years he was project manager of ESM systems at Reston, VA. . . . **E.G. Sherburne, Jr.** director of the Westinghouse Science Service Talent Search, was found writing in *Education Week* about the difficulties of attracting talented students to math and science teaching. What else is new?—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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The *Gloucester* (Mass.) *Daily Times* doesn't spell very well. Just got an article headlined "N.H. Lawyer quests for the Lock Ness Monster." In the body of the article they do spell it "Loch Ness" . . . but with the dearth of news, we can't be fussy! The newsclip tells about **Bob Rines**'s problems in his search for the monster since 1975. Bob's latest plan is to miniaturize Doc Edgerton's equipment and strap it on the backs of really smart dolphins! So if any of you have access to some really clever dolphins, do get in touch with Bob at the Franklin Pierce Law Center at the University of New Hampshire. Personally, I can hardly wait for the next installment of this saga.

Art Power writes from Colorado that he is principal process engineer for the Solar Energy Research Institute doing technical evaluation on fuels from renewable resources. Art has also resumed his Educational Council work with the M.I.T. Club of Colorado. . . . **Robert S. "Hawk" Shaw** tells about the M.I.T. Club of New Hampshire and also about all sorts of interesting goings on in his part of the world. Turns out that the governor of N.H., John H. Sununu, '61, is also **Charlie Stempf**'s brother-in-law. Hawk and Charlie have been trying to get in touch with **Phil Phaneuf**.

For all concerned here is Phil's business address: General Dynamics Corp., 1675 W. Mission Blvd., Box 2507, Pomona, CA 91769. His home address is: 521 West Mt. Carmel Dr., Claremont, CA 91711. Suggest that you three not write to each other, but that all write to me, NOW! Then I'll put the letters in the next class notes and you can all read the correspondence, thus saving a bunch of postage, particularly to Australia.—**L.K. Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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There has been a little better yield of news this month, but the returns are still not what they should be. Nevertheless. . . . **Thomas A. Mitchell, Jr.** has been designated a fellow of ASME. Tom is presently rounding out a 41-year career with Eastman Kodak as a senior research associate in the Research Laboratories at Kingsport, Tenn. During his years with Eastman, Tom has been involved in the electromagnetic separation of uranium isotopes, acetate yarn production, synthetic fiber and plastic research, and research management. Elevation to the rank of fellow recognized Tom's distinguished industrial career, as well as his service as chairman of the East Tennessee Section of ASME.

A pleading postcard elicited a response from **Bob Casagrande**. Bob retired last October 1 after 41 years with Shell, working most recently as staff engineer in the Technical-Oil Products Dept. of the Norco Manufacturing Complex, 25 miles upriver from New Orleans. Bob's final job was editor-in-chief and co-author of a three-volume treatise, *Process Guide for Catalytic Cracking*, to be used mainly by the technical support engineers at Shell's seven domestic refineries. This satisfied a long-standing "literary urge." Bob expects now to do considerable traveling with his wife Kathleen, including more frequent visits to his three children, who are located east, west, and center. He also hopes to upgrade his golf game.

Hearken to my cry! Send more news.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Double thanks to the following for their gifts to M.I.T. and for adding notes to their Alumni Fund envelopes. **Harold A. Miller** writes that he is "currently vice-president, operations, of a folding carton manufacturer in Alabama while trying to amass sufficient capital to start a new career as an attorney in solo practice." . . . **Edward P. Radford** writes: "Will finish at Hiroshima, Japan at end of year, and join my wife in Singapore until she finishes a WHO consultance. Future plans are then to retire to England but will still be active in U.S." . . . **John E. Stevens** notes, "After 24 years at AVCO Systems Division in Wilmington, Mass., where I held various technical and management positions primarily working on strategic missile systems, I am now corporate vice-president of technology development in charge of corporate R&D strategic planning." . . . **Albert B. Van Rennes** is continuing as U.S. technical advisor to Indonesia's minister of State for research and technology in Jakarta.

After writing this column for nine years (June 1976 through April 1985), your secretary is stepping down. We are happy to welcome **Lou Demarkles** and **Andy Corry** as the new class co-secretaries, having quickly moved up the ranks from the February/March issue, where they were inadvertently listed as assistants. Please help Lou and Andy keep this column going by sending news to them.—Secretaries: **Melissa Teixeira**, 92 Webster Park, W. Newton, MA 02165; **Louis Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181; **Andrew Corry**, Box 310, W. Hyannisport, MA 02672

45 40th Reunion

. . . and two months from now our 40th reunion shall be history. In late January you should have

received your 40th reunion packet from Reunion Chairman **Tom McNamara** and his hard working committee. I, too, was aghast at the cost of the total reunion package; yet once I dissected its various components I concluded that overall it was a good deal—and we trust that you all reached the same conclusion. Our 40th reunion will not be a roaring success unless you attend. Fran and I look forward to seeing you there.

Richard H. Battin, associate head of the NASA Department at Draper Labs was inducted as a fellow of the American Astronautical Society at its annual awards luncheon last October in Palo Alto, Calif. Only one other Draper employee has been so honored, and it was the "Doc" himself! Dick continues active at the Institute. He will be publishing eight chapters of an astrodynamics text to be used by his M.I.T. students in a course he continues to teach each year.

Jim Hoaglund, executive vice-president of Snyder General Corp. in Minneapolis has been elected second vice-chairman of the Air Conditioning and Refrigeration Institute; ARI is the major trade association representing manufacturers of indoor climate control equipment. During the first half of 1984, Jim worked diligently to turn his McQuay operation around (sound familiar?). The prospects were bright—and then. Yes, merger time! Dick Snyder, owner of Snyder General Corp., announced a tender offer for McQuay stock. After the usual retching negotiation period, the tender price was upped to the point that Chairman Jim of McQuay recommended to his stockholders a friendly takeover. Snyder gave Jim a great management contract but no responsibility. As of January, Jim turned the no-responsibility contract into a consulting deal which gives him the opportunity to explore! Join us at our 40th to learn the outcome.

In a late December letter **Art Miller** forwarded **Jim Shearer**'s obituary. Jim, a senior physicist at the Lawrence Livermore National Laboratory for the past 27 years, died of a brain tumor on October 9, 1984; he was 60. Jim's basic interest was in magnetic fusion energy; he also studied nuclear design and worked with high-explosive driven electrical generators. In addition to his deep love of physics, Jim was also interested in meteorology, was an amateur musician who played the trumpet and alphorn, and gave instruction in English country dances. He is survived by his wife, Gail Marie, and two sons, Jim and Peter. . . . Back to **Art Miller**. Art and Jim Shearer worked together at Livermore before Art left for grad school at Berkeley and then on to Princeton where he continues his fusion activity. It is gratifying to note that academia suffers from the ills of industry-namely annual budget reductions!

Another death—**Donald T. Cloke** of La Grange, Maine on July 21, 1984. Don spent his freshman year at the University of Maine before joining the V-12 at M.I.T. in July 1943. After the navy, it was Cornell graduate school, a few years with General Electric in Syracuse, and then back to Maine with Bangor Hydro. The only survivor, his brother Paul of Ann Arbor, Mich., is establishing a memorial scholarship fund in Donald's name at the Institute.

Now for a few Christmas card one-liners: **Al Bowen**'s wife Billie will not be at the reunion as she has a family wedding in California. . . . **Chris Boland**, our 40th reunion gift chairman, reports that we were at about $700,000 in last December. . . . **Charlie Patterson**, reunion sports chairman, is honing his golf game. . . . After two years of misery with his eyes, **Pete Hickey**'s attitude has returned to that of "old"! . . . **George Bickford**, is now selling computer systems to dentists.

George Hetrick's son Blaine graduates from high school at reunion time. . . . Edna (Mrs. **James "JJ") Strnad**'s Vassar 40th reunion is June 7-9. Care to wager where Edna and JJ will be? Let's hope it is both places! . . . **Nick Mumford** continues to work full time as a volunteer at the Episcopal Diocese of Detroit. Family reunion at our 40th, as son Nick will be back for his 15th at Tech. . . . **Tom Stephenson**'s news will wait for reunion. . . . **Jim Brayton** advises that he is in regular touch with **Jake Freiberger**.—Think REUNION!—**C.H. Springer**, Secretary, Box 288, New Castle, NH 03854

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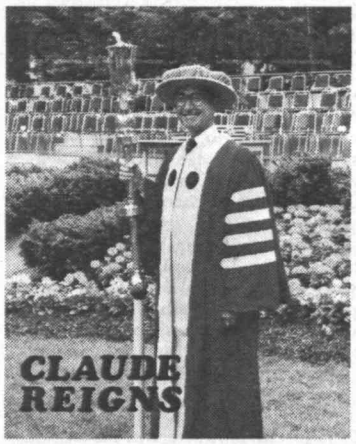
In the heart of the Christmas season here in "Big D" and nary a word from classmates, except good ol' **Bill Cahill**, who sent a beautiful pen and ink rendering of the Cahills' new house overlooking Lake Tahoe in Glenbrook, Nev. He also sent the rather astonishing news that he not only been to Maui (Wowie!) in November, and not only played golf, but played in a Pro-Am tournament with Lee Trevino as his partner! And not only that, but he shot a 79 and a 74; claimed it was the best time he's ever had in 50 years of golf. Boy! I guess so.

And what are all you other amigos doing now that it's the spring of '85. Trust you're making your long-range plans for the 40th in the fall of '86. I'm just joing to keep harping on this issue 'til I get some positive motor responses. SO WRITE ALREADY!—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222



Thank You, Claude Brenner

"Priceless, Rare Edition" reads the above specially created* Technology Review *cover for Claude W. Brenner, '47 (see page 2). Upon his retirement as chairman of the* Review*'s Advisory Board, Peter Gellatly, business manager, presented the gift and expressed the staff's appreciation: "He was supportive, articulate, demanding when necessary, and most important of all he was always there when we needed him. For these and many other contributions to the growth and betterment of* Technology Review *we say thank you, Claude Brenner."

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Arrangements for our Newport multi-class mini-reunion will have been in place for many months by the time you read this, the result of the efforts of a tri-class committee headed by **Bob Horowitz**. I hope you were one of the lucky ones who was early enough with your reservation. The Petit Trianon er . . . excuse me, Rosecliff, the Petit Trianon Replica, awaits us, with its heart-shaped staircase for that entrance you have always wanted to make, and a dinner menu you wouldn't believe. (Claude, Mr. President, please: can you arrange to have us announced as we descend?) At this writing (January—coldest day; remember?), Saturday clambake plans are under way and Sunday brunch is only a matter of finding a place that will get up early enough to feed our size crowd. Check your mailing(s?) for information about the other activities. You who can't make it this year: we'll tell you all about it and hope to see you at our Grand Fortieth in 1987 (Good Lord! 1987?)

Last August **Ralph Coburn** was the featured artist at Point Hill Gallery in East Gloucester. Ralph returned to M.I..T. in 1957 as a graphic designer for publications after continued study in painting and drawing, study which included a year at the Academie Julian, Paris. He has participated in exhibitions in London, New York, Boston, and Tokyo and has won many awards for graphic design. His work is in the collections of the Chase Manhattan Bank in New York, the Smithsonian, and the Stedlijk Museum in Amsterdam.

Our class was well represented in the list of new members elected to the National Academy of Engineering, which recognizes contributions to engineering theory and practice, including the literature of engineering, and unusual accomplishments in new and developing fields of technology.

Harl Aldrich, Jr., senior principal and president, Haley and Aldrich, Inc., Cambridge, was cited "for fundamental contributions to understanding of freezing problems and preloading techniques, and also for leadership in development of geotechnical engineering practice." . . . **F. Paul De Mello,** vice-president and principal engineer, Power Technologies, Inc., Schenectady, N.Y., was recognized "for major advancements in dynamic analysis of electric power plants and systems benefiting design, control and training application." . . . **John W. Leonard,** vice-president, engineering, Morrison-Knudsen, Inc., Boise, Idaho, was selected "for innovative application of engineering to major construction projects, especially in the areas of mechanized tunneling, coastal, and harbor construction." . . . **Stanley K. Weissberg** has resigned as president and CEO of Yardney Corp., Pawcatuck, Conn. Hope to see you all in June.—**Virginia Grammer,** Secretary, 62 Sullivan St., Charlestown, MA 02129

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In December our seventh annual Boston area mini-Reunion was attended by Ginny and **George Clifford**, Gloria and **Sonny Monosson**, Barbara and **Malcolm Reed**, Nancy and **Don Noble**, Anita and **Verity Smith**, Judy and **Graham Sterling**, Tel and **Bob Sandman**, Jean and **Milton Slade**, Eleanor and **Harold Ottobrini**, **Manny Kramer** and his fiance, and yours truly. We met at the Wellesley Club and enjoyed after-dinner music played on the guitar and flute. When we sang the M.I.T. Stein Song, the instruments were overwhelmed by the vocal chorus. It was all good fun, including verses of "I wish that I were back again at the Tech on Boylston Street."

Claude Brenner, president of '47, attended with Peggy Hall and took part in our discussion of the 1985 joint reunion of '47, '48, and '49. **George Clifford**, **Bob Sandman**, **Harold Ottobrini**, and myself are on the reunion planning committee. It is planned for June 8-9, 1985, the weekend following Technology Day in Newport, R.I.—our 37th reunion. Current plans include a dinner and dance at Rosecliff mansion in Newport. Rosecliff has the most suitable ballroom of all the mansions in Newport. Dress will be formal for the dinner and dance. There will be a flexible day allowing you the choices of visiting Newport mansions and historic buildings, tennis, shopping on Bowen's Wharf, sightseeing boats from Newport Harbor, and sailing.

Plans for our 40th reunion gift to M.I.T. have

taken a giant step forward. **Denny McNear** has accepted **George Clifford**'s request to be chairman of the reunion gift committee. Denny's business experience as chairman and CEO of Southern Pacific Transport Co. and his alumni experience as president of the M.I.T. Alumni Association will be valuable assets to our gift committee. I expect that Denny and our committee will be calling on all of us to support our class gift. If you have the interest, why not surprise Denny and volunteer your support.

I am writing this while flying to Los Angeles to visit Eileen and **Bill Zimmerman**. Bill has operated Zimmerman Holdings for seven years, and currently his firm owns 12 companies. The companies range from aircraft hardware, to electronic devices, and to capital equipment for process industries. During the seven years, Bill has acquired 23 companies, but some were merged and some were divested. Bill has one staff member and one assistant to operate Zimmerman Holdings. The companies operate in several states, Mexico, and Canada.

Bill and Eileen are planning a visit to Brazil, where they will stop at two places along the Amazon River before going to the area near Rio de Janeiro. Bill's daughter, Amanda, is a sophomore at San Marino High School which is near Bill's home in Pasadena. Amanda is active in tennis and is a manager of the boy's basketball team. Bill enjoys receiving calls from classmates when they are in the Los Angeles area.

Frank Heilenday has written a textbook on air vehicle penetration, in addition to teaching a course on the subject at the Strategic Air Command Headquarters in Omaha. Frank spent 30 years with SAC before retiring from his post as chief of applied research.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02806

50 35th Reunion

Melvin J. Gardner is presently senior vice-president, chief financial officer, and director of Swanton Corp., located in New York, N.Y. . . . Last October 31, **Robert C. Carruthers** retired as president of Nutmeg Steel Castings Corp. and left that day for a month in Japan and the Peoples Republic of China. . . . **Alfred Gallucci** of Fairfield, Conn. has been elected vice-chairman of the board of directors of The North American Bank & Trust Co. Mr. Gallucci is a general partner in Deer Park Associates, an investment group in Fairfield. He is also a partner in EED Partners, distillers and distributors of EE Dickinson Witch Hazel. He has been a member of the North American Board since 1977. . . . Corning Glass Works of New York recently announced the appointment of **Donald E. McGuire** to vice-president, engineering. Mr. McGuire joined Corning in 1955 and since 1982 has been director, engineering, Corning Engineering.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10H, Boston, MA 02114

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Amar Bose, who founded the Bose Corp. in 1964, the $100 million loudspeaker company which is ranked No. 1 among domestic manufacturers in U.S. sales, announced the development of a new portable sound system code named "Son," an acoustic wave music system that recreates a "deep, heartfelt bass" normally found only in much larger speaker systems. . . . **Richard M. Davis** is currently vice-president and general manager of the Michoud Division, Martin Marietta Corp., which manufactures external tanks for the space shuttle. . . . **John J. McEvoy** reports he is currently with DuPont, Polymer Products Department, as marketing manager for Latin America. Four of their seven children have married, blessing them with eight grandchildren. . . . **Frederick G. Lehmann** has been appointed vice-president for Institutional Advancement at New York Medical College. In his new position, Fred is responsible for all aspects of institutional advancement, including the development of programs, fund raising, and the establishment and maintenance of relationships with corporations, foundations, alumni, parents, and friends of New York Medical College.—**Gregor J. Gentleman**, Secretary, 600 Holcomb, Suite 1, Des Moines, IA 50313

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We've had a lot of responses this month to our request for news, some of it sent in with contributions to the Alumni Fund. **Marion C. "Mandy" Manderson** informs us that he's been operating his own consulting practice for the past 11 years. He has four children, three of which are still in school. Mandy is living in Orlando, Fla., now but he may be moving to a summer place in Virginia in a year or so. Are you thinking about an early retirement, Mandy?

We heard, too, from Dr. **Yechiel "Jack" Shulman** that he recently took on the position of president of MMT Environmental in St. Paul, Minn., a company that designs, builds, and markets air pollution control equipment and also performs environmental studies.

Two brief notices were received about classmates. They're somewhat cryptic, so I hope I've interpreted them correctly. If not, please let me know. First, **John G. Polk** was promoted to executive vice-president and sector executive for packaging at American Can Co. in Greenwich, Conn. Also, Professor **Yu-Chi Ho**, who is with Network Dynamics, Inc., in Cambridge, Mass. is now a Gordon McKay professor of engineering and applied mathematics at that school upriver, Harvard University.

A newsclipping from Perkin-Elmer in Norwalk, Conn. informs us that **George D. Cheney**, who lives in nearby Wilton, is now a principal engineer at that company. George has worked there for 17 years and is a mechanical engineer working in the systems operations division. For the past six years, he has been involved in the Hubble Space Telescope program.

Another recently honored mechanical engineer is **James P. Johnston**, a professor in the Department of Mechanical Engineering at Stanford University, who has been named a fellow of the American Society of Mechanical Engineers. In case you've lost track, he's been at Stanford for about 24 years, and his most recent work involves diffuser technology and radial flow turbomachinery fluid dynamics.

For all of you who enjoy statistics, I've calculated that only about ten percent of the class has been mentioned in these class notes since May 1983. We would still like to hear from and about the rest of you before our next reunion in 1988.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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A mild winter in southern New England (so far) has seen the holidays come and go with very little of the slippery roads, ice-felled trees, and other wonders of nature associated with this time of year. Maybe that will change by the time you read this. In any case . . .

Paul Drouilhet has been appointed assistant director of Lincoln Laboratory, effective January 1. Paul has been with the laboratory since 1959, following his tour of duty with the air force. He has been involved in the development of communication techniques for satellite systems and for very low-frequency radio channels. He has worked particularly in air traffic control and has headed the Division of Surveillance and Control at Lincoln Laboratory since 1978.

Klaus Zwilsky has been installed as a trustee of the American Society for Metals. Since 1981, Klaus has been executive director of the National Materials Advisory Board, a unit of the National Research Council. Prior to his present assignment, he worked successively for New England Materials Laboratory, Pratt and Whitney Aircraft, Melpar, Inc., the Navy Ships Research and Development Center, the Atomic Energy Commission, the Energy Research and Development Administration, and the Department of Energy. At the latter agency, he served for eight years as chief of the Materials and Radiation Effects Branch of the Office of Fusion Energy.

That's about all the news we have this time. Let us hear from you.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55 30th Reunion

There aren't that many important events in your life. I mean you can miss a lot of things, and no one cares. Last night I missed the symphony, and I hardly even noticed. They didn't either. If it's anything really big, they'll come and get you. This will be true of your funeral. Also, if you grow a giant zucchini that violates a town ordinance, they'll come and take you away.

But there is an enormous event looming in your life, a veritable mastodon in the doghouse of daily circumstance. You must attend. Life is more than a little Soave with the McNuggets then a snooze on the sofa. Get up and celebrate your 30th reunion!

The festivities start with a dinner and the Pops on Thursday, June 6. On Friday afternoon, we head for a weekend at the Harbor View Hotel on Martha's Vineyard. We had a great time there on our 20th reunion, and you can expect an even better time this year.

You won't be alone. Over 120 classmates have shown an interest in coming; among them are the following:

New England—**Brewster Ames, Stan Amstutz, Paul Attridge, Rowe Austin, Mel Barkan, Bob Baker, Stan Barriger, Robert Bartlett, Phil Brooks, Pierre Brosens, Art Brownlow, Frank Buck, V. Chernyshov, Bob Djorup, Robert Dunn, Bill Engstrom, John Farmer, Alan Friot, Sam Goldman, Glenn Jackson, Clarence Kemper, Jack Kennaday, Roger MacKay, Rick Morgenthaler, Roger Reiss, Frank Scammell, Joe Saliba, Allan Schell, Herb Singer, Ash Stocker, Jim Storey, Jack Sutton, Victor Tyler, Mel Weiner, Harold Wells, Mike Wislotski, Bernie Wuensch, Jerry Zindler, Russ Collins, George Coxeter, Elmer Crouthers, Bob Dettmer, Gene Davis, Charles Henry, Bill Lehmann, Barrett Lucas** and **George Raymond**.

New Jersey and New York—**Richard Bergman, Bob Buntschuh, Wen Chen, Ed Elizondo, Phil Eisner, John Gahran, Harry Mogensen, Bob Posner, Don Steig, Allen Wahlberg, Gary Brooks, Harold Cohen, Stefan Geiringer, Marc Gross, Jacques Linden, Marty Raab, Henry Schmitz, Marty Shooman**, and **Jim Stone**.

Midwest—**Bob Cruickshank, Rod Joblove, Sid Parry, Karl Reuther, Charles Robertson, Randy Robinson, Cora Sleighter, Olaf Stackelberg, Chan Stevens, Hal Stubing, Dean Zeilon, John Ackley, Frank Curran, Bill Friedman, John Lindenbaub, Ed Pulsifer, Greg Robillard, Ralph Wanger**, and **Doug Wixson**.

Atlantic States—**Fred Brooks, Al Cron, Dick Dangel, Joyce Davis, Jim Eaker, Gus Kabeschat, Dell Lanier, Lester Lee, Stu Peltz, John Polutchko, Walt Rubin, Harry Schreiber, Carl Seils, Ernie Strait, Eric Theis, Eric Thompson**, and **John Wing**.

South and Southwest—**Bert Borngesser, Elliot Cramer, Joe Lombardo, Fred Lupton, Dan Kiser, Len Sugerman, Pete Toohy**, and **Robert Wilkes**.

West Coast—**Prentiss Cole, Dick Hall, Andy Hengesteg, Mike Horstein, David Kramer, Bruce Landry, E.C.F. Lee, Tom Marlow, Paul Mosher,**

Eldon Reiley, **Bob Trainer**, and **Lee Zuker**.

Overseas—**Per Klem**, **John Koeneman**, **George Rubissow**, **Roy Salzman**, **Demi Stephanou**, and **Pierre Casimir-Lambert**.

This stellar occasion will be guided by our reunion champion, **Glee Jackson III**. If you've lost your mailing, write to him at 8 Paige St., Hingham, MA 02043, and say you're coming. You'll be glad you did. Really. The first letter for the reunion described a drawing for a free reunion packge for two, to be selected from those who responded by December 1. The lucky winners of the drawing are **John Polutchko** and his wife, Peggy. There will be a second drawing from the list of those responding to the next reunion letter.

See you at the reunion!—Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

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The request for class dues made in this column a few months ago not only resulted in additional receipts for the class treasury, but also in some information that facilitates my writing of this month's notes. In partiular, I would like to share the following letter which I received from **Mike Turin**. He writes, "I believe I'm one of those classmates who has yet to pay his dues, and I want to be in the loop for the next reunion. Every five years is about right to meet with the boys." . . . "Our family has stabilized at two boys and a daughter. The older boy is at the University of Arizona going for a master's in geohydrology. The middle (boy) is in Seattle, after graduating from St. Lawrence University, making pasta for restaurants and finding out about life. My daughter is a junior at Bucknell, and is having a great time.

"I am still with the International Division of IBM (27 years now), just promoted to divisional director, and am now in charge of all technical support for the World Trade Corp. and the 131 countries in which the IBM logo appears. It has to be the best job in IBM, and although it involves a bit of traveling, about 125 days a year, I do get to see the world in style. And with the kids out of the nest, Phyllis (also 27 years now), is able to travel with me a significant part of the time." "We've put down roots in Westport, Conn., down the street from Paul Newman's house, and he is not half as good-looking as claimed! All in all, it's been a hell of a ride for the money, proving the old adage, 'If you have to chose between luck and skill, always chose luck. You can always beat skill, but never beat luck.' "

Wallace P. Mack III, Course VI, left the Satellite Business Systems after ten years to become the division director for Transmission Systems Engineering for the Government Systems Division of Western Union in McLean, Va. Wally has a son at Rensselaer Polytechnic Institute, which he chose over M.I.T., and as Wally noted, "You can't win them all." I find it interesting to note that Wally is still in transportation. He lived down the hall from me on the fifth floor of Burton House at the start of our freshman year in September 1952. He was one of the few freshmen members of the class of 1956 with wheels, being the proud possessor of a 1929 Ford, which even then, was a vintage classic, but which served as the sole means of private transportation for many of Wally's neighbors in Burton Five West.

Edward W. Boggs, Course I, is vice-president of Capitol Engineering Corp. in Dillsbury, Pa. He retired as a lieutenant colonel in July 1984 after 28 years of total Air Force/Air National Guard service. His last command was the 193rd Special Operations Squadron of the Pennsylvania ANG.

On the behalf of the class, I would like to offer condolences to the family of **Vernon V. Hukee**, Course VI, who died last September after a long illness. Vernon served in the diplomatic service for eight years abroad and was an employee for many years of Sprague Electric Co. He was a member of the Nashua Lions Club, and taught as a volunteer at the Adult Learning Center of Nashua, N.H.—Co-secretaries: **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345; **Caroline D. Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818

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Alar Toomre, professor of applied mathematics at M.I.T., has been awarded a MacArthur Foundation tax-free $230,000 award over a period of five years for his achievements in astronomy. Professor Toomre does extensive research in theoretical astronomy, and the bulk of his work is on the dynamics of galaxies.

Gerald (Jerry) Marwell wrote from the Department of Sociology at the University of Wisconsin, Madison, where he was professor and chair of the department. As you read this column, Jerry will be enjoying a sabbatical year, although research projects will bring him back to the University periodically. Jerry's wife, Bobbie, remains a psychologist with the school system where she has become an in-house researcher. Jerry and Bobbie recently co-authored a paper on the long-term effects of early school placements. Son Evan is a sophomore at Harvard, where he majors in economics; daughter Nicole is a high school junior and all-state soccer player.—**Vivian Warren**, Secretary, 156 Northrop Rd., Woodbridge, CT 06525

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Here's some news from 1984. . . . **Jerry Schooler**, who with his wife Virginia, owns Largashall Wines, located in Petworth (one of the places where Turner painted, as I recall) in West Sussex, England, reports that he couldn't attend our 25th reunion because he was in the middle of successful negotiations to buy the Malmesbury Mead and Country Wines Co. The Schoolers report the sobering statistic that they now have over 15 percent of the Mead business in the U.K. . . . **David Klein**, who lives in Ludlow, Mass., reports on his September appointment to the faculty of Western New England College in Springfield, where he's teaching physics. . . . **Bob Coward** writes that he's pursuing his interest in science policy as vice-president of the Center for Research Planning, a consulting company that produces bibliometric models of scientific activity that government agencies and industrial corporations use for evaluating and managing research.

Marie Wray writes that she's a member of the technical staff of Aerospace Corp. in El Segundo, Calif. (her husband Stan, '56, is a section manager there) and that her son Tanner and daughter Tina graduated from M.I.T. in 1981 and 1983 respectively. . . . **Nam Sah**, professor of mechanical engineering and director of the Laboratory for Manufacturing and Productivity at M.I.T. was tapped by the White House to be National Science Foundation assistant director in charge of NSF's expanding engineering and research program. The *Wall Street Journal* reports that **Carl Neu**, president of his own Denver based consulting firm, has developed a successful patient-relations program, Pro-Med, that provides niceness training for 200 client hospitals. A "dose of smiles" the *Journal* calls it. . . . **Alfredo Kniazzeh**, who manages an R&D lab at Polaroid, sends along a photo from Fort Pierce, Fla. of his bearded self, his 14-year-old son, a mysterious gentleman in dark glasses, and (in the background) four very large fish that they caught. The photo is on Kodak paper(!) . . . which proves that Alfredo does some of his R&D in Florida.

Some 1984 promotions: **Dwaine Smith**, from vice-president, employee relations to senior vice-president at Atlantic Richfield in Los Angeles; **Bruce Blomstrom**, from senior vice-president, Alpha Theraputic Corp. to vice-president, corporate development at Whittaker Corp. in Los Angeles; **George Haymaker**, from vice-president, International, Aluminum Co. of America to executive vice-president at Alumax, Inc., San Mateo, where he will head the Aluminum Group.—Secretaries: **Myer Kutz**, 320 Riverside Dr., New York, NY 10025; **Arthur Collias**, 24 Hemlock Dr., Canton, MA 02021; **Ron Stone**, 116 Highgate Pl., Ithaca, NY 14850

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Reunion time is rapidly approaching! If you haven't already set aside June 6-9 to return to M.I.T. to see your fellow classmates and their families, do so right now and let us know! Well over 100 of us are planning to be there, many with spouses and children.

For instance, **Ray Waldmann** will be there with his wife and two kids. Ray was assistant secretary of Commerce from 1981 to 1983, and is now chairman of Trans National, Inc., an investment and trade consulting firm. . . . **Bhupendra Khetani** is coming with his wife and two kids. Bhupendra is vice-president and director of Worldwide Business Development with Owens-Illinois, Inc. . . . **Robert Miller,** currently director, MIS for Colt Firearms is planning to attend. . . . So is **Raymond Ambrogi**, whose new job is director of Product and Technical Development, Consumer Products Division, Corning Glass Works. . . . **Rosaria Piomelli** is coming with her child. Rosaria was the distinguished professor (Chancellor's Lectureship) at the University of California at Berkeley for fall semester 1984. . . . **Michael Kasser** hopes to attend. He writes, "I married Beth Chadwick in August (her first, my second) and we honeymooned in Hawaii, where I competed in the IRONMAN Triathlon and finished 108th out of 1,100 starters, sixth in the over-40 category. We're living off theatre and real estate." . . . **Barry Karger**, currently director of the Barnett Institute at Northeastern University, plans to attend, as does **Roger Hohman**, retired major and now senior manufacturing engineer for software distribution with Digital Equipment Corp.

Sheldon Epstein writes, "Several weeks ago, I was delighted to receive a telephone call from ex-roomie **Herb Thaler** who invited me to attend our coming class reunion. I was looking forward to joining all of you until Suzy looked at the calendar and informed me that our daughter, Liz, would be graduating from high school that day. Sorry folks. In anticipation of the types of questions usually received at reunions, I wish to provide the following answers. I am in good health. My weight is 165 lbs., which is acceptable for my 6-foot skeleton. I still have almost all my own hair—and it's about 60 percent black. Suzy and I are still on our first marriage—24 years. Our son Sam will be 21 in June and is in charge of software development in our business, Epstein Associates, located in Northbrook, Ill. Liz has been accepted at Moore College of Art in Philadelphia, where she plans to major in either fashion design or fashion illustration. Suzy's career as an art historian and lecturer is flourishing, and we don't anticipate any "empty nest" problems because we're both too busy. Continuing with more reunion questions, Epstein Associates builds and services microprocessor-based systems for process control, data acquisition and instrumentation. It is my second career (law being the first until 1978, the year I received my M.B.A. from University of Chicago), and we're delighted with it. We've been successful enough so that I could switch from the Democrat to Republican party in 1980 to vote for President Reagan. My only attempts at public office were two unsuccessful tries for school boards. My principal hobbies continue to be amateur radio and photography. In 1983, we built a seven-and-one-half foot parabolic satellite antenna, which we mounted on a 22-foot mast (interesting Course II problem) behind our home. This was our first step in outer space research. NASA take note: We're ready to answer your call for service to computers in orbit! We'll be think-

ing of you in June. Thanks, Herb, for calling." . . . A couple of others who have sent their regrets are **Kurt Pollak**, who recently joined Union Carbide R&D as manager of technical recruitment, and **William C. Behrmann**, a senior engineering associate with Exxon Research & Development Labs in Baton Rouge. Bill sends "greetings to all former colleagues and faculty members."

A number of classmates are still on the fence. Why not give them a call and threaten them with mayhem if they don't show up, or just urge them to come for a good time! These include **Benjamin Johnson**, division supervisor for Sandia National Laboratories; **Peter Sugar**, an associate of Brown, Daltas, and Associates, who wrote that he is "presently at their office in Rome, Italy, but will be returning to Cambridge in 1985"; and **Steve Shimberg**, who writes that he has been with IBM for nearly 20 years, the past 13 in Columbus, Ohio. He is a specialist in retail point-of-sale systems, has a daughter that is a sophomore at Brandeis and a son who is a sophomore in high school. His wife, Orlene, teaches in a private school locally.

Also undecided are **David Klahr**, who was recently appointed head of the Department of Psychology at Carnegie-Mellon University; **L.R. Swain**, who has been senior vice-president of Datacon, Inc., since February 1984; **David G. Adler**, currently a senior project manager in the Fossil Power Division of Babcock and Wilcox; **Rudy Marloth**, who responded from Los Angeles, but didn't tell us what he's currently doing; and **Thomas Christy**, who is with the U.S. Naval Surface Weapons Center, Silver Springs, Md., and notes that he plays two games of ice hockey a week and is percussionist with the Gilbert and Sullivan Opera Company orchestra.

More "maybes": **Dick Oeler**, who wrote that he was attending the Harvard Business School Advanced Management Program and enjoying Boston again; **Owen Martinez Sandin**, who presently occupies the position of associate vice-president for planning at the Puerto Rico Interamerican University in San Juan; and **Mike Padlipsky**, who is plugging his book, *The Elements of Networking Style*, published by Prentice-Hall this year. We hope you'll all be able to make it!

Dan Whitney, section chief in the Robotics and Assembly Division at the Charles S. Draper Laboratory, Inc., has been elected a senior member of IEEE. . . . **Papken S. Dertorossian** is currently president and chief operating officer of Silicon Valley Group, Inc., Santa Clara, Calif. . . . **Richard de Neufville** is professor and chairman of the Technology and Policy Program at M.I.T. . . . **Gordon W. Moore** writes, "In my almost 25 years since graduation from M.I.T., I have been actively involved in the computer business in Chicago, San Francisco, and Denver. The past few years I have enjoyed an emphasis on the use of microcomputers in business applications with my own company. My wife of 20 years, Kathleen, and I enjoy a family of three sons—Jeff, Dan, and Joey—who were joined four years ago by an "eldest son," Hoa Van To, who escaped from Vietnam as one of the boat people. For the past 12 years, we have made our home in our native Denver and have very much enjoyed an active role we have taken in M.I.T. alumni and Educational Council activities in Colorado."

So that's it for now, gang. Get busy and send in your reservation for the reunion, and I'll see you there!—**Noel S. Bartlett**, Secretary, 15320 Edolyn Ave. Cleveland, OH 44111

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Thanks to all of you who sent me a bumper crop of news. **Mike Bertin**, former class secretary, responds to my question "Would you send your daughter to MIT?" with a resounding yes. Amy Bertin is a sophomore, having a wonderful experience, and living in (where else?) Burton House. She works her tail off, but has time for a few hacks. For instance, she and a friend dressed up as Bert and Ernie for a talk by Jim Henson, creator of the Muppets. Henson first lost his aplomb, then spoke directly to Amy and her friend *as Ernie*.

Mike reports about some classmates: **Roger Gans** has done postdocs in applied math and aeronautics and astronautics, teaches mechanical engineering at the University of Rochester, and is also into acting, cross-country skiing, motorcycling, and his second marriage. . . . **Bob Kurtz** is a general surgeon at Mt. Sinai Hospital and Bronx VA Medical Center, divorced, but the father of Holly, 13, and Elizabeth and Amy, twins, 11. . . . **Dick Males** and his wife, Barbara, live in Cincinnati with sons Nathaniel, 10, and Matthew, 19. He is in the private practive of environmental engineering, and plays clarinet, juggles, swims, and hunts mushrooms. . . . **Lewis Neuman**, with an M.B.A. from Harvard, has been in a family zipper business, and has boys 13 and 15. . . . **Raphael Soifer** also went to the Harvard Business School, and is now an analyst with Brown Bros., Harriman, in New York. He and wife Arlene have sons Donald, 17 and Brian, 11.

I got a lovely season's greeting card from **Rick Merrill**, who is living in Bolton, Mass. with wife Marge; his mother; Julie and Jennifer, each 14; John, 10; Jill, 5; and Jayne, born November 23, 1984. He says, "I would love to have my child(ren) go to M.I.T. *but* the projected cost . . . (for a newborn) is $138,000!" . . . **Ron Walter** spent six years in New York City government during its fiscal crisis, including time as chief financial officer of its hospital system, and then five years in the equipment financing and leasing business at Citicorp. His wife, Marilyn, is on the faculty at Brooklyn Law School, and Amy is in the fifth grade.

Recent immigrants to Orchard Lake (southeastern), Mich. are **Larry Kazanowski**, his wife, Cora, and Kristin, 6, and John, 4. Larry has spent 20 years with Ford Motor Co., most recently as director for Overseas Environment Evaluation. . . . **Eugene Meieran**, living in Los Altos Hills, Calif. and working for Intel Corp., was last October made one of its fellows.

Mike Chessman writes, "Still happy in Porrola Valley, Calif. Visitors welcome. With wife, Mary, and two daughters (15 and 18), we are relearning how to ski." . . . Having served in the White House (National Security Council) two years, **Henry R. Nau**, who lives in Rockville, Md., has returned to George Washington University, in D.C., where he is professor of political science and international affairs.

Bob Mason lives in Atlanta, where he has a consulting firm, Metrics Research Corp., in microcomputers and information systems. . . . **John Wasserlein**, who was promoted a year ago to vice-president and general sales manager of Boise Cascade's Pulp, Publishing, and Packaging Paper Division, has relocated to West Linn, near Portland, Ore.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218

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Hello again. As this is being written, the New Year has just been rung in. The festivities here in Boston are called First Night. This year, roughly a million people participated in various events throughout the downtown area. The finale is a fireworks show over Boston Harbor. The large size crowd was in part due to warm weather—temperatures in the 50s; not bad for Boston in winter.

Speaking of warm weather, your faithful scribe is just back from a scuba diving trip to Cozumel, Mexico. As a newly certified diver, I haven't made it past the fanatic stage yet. I'll recommend the sport (and show my pictures) to anyone.

On the way south, I had the opportunity to visit Fort Worth and enjoy the hospitality provided by **Jerry Weiner** and his wife Sylvia. It offered the chance to meet their daughters Melissa and Jenny, who are about as delightful as two young ladies can be. Jerry's travel business is prospering; he, Sylvia, and the girls have seen and enjoyed a great deal of the world .

Phil Townsend forwarded a copy of a letter he recently received from **Doug McCallum**. Doug is living in Bandung, Java, Indonesia, where he is employed by University College, London, helping the Institute of Technology in Bandung establish graduate programs in civil engineering and in planning. He and his family arrived in Java in 1982 after having spent most of the previous 13 years in Europe, mostly as a faculty member at the University of Glasgow. Doug and his wife Jan "are still married and living together—voluntarily and happily." They have four children aged 13, 12, 11, and 9 in a boy-girl-girl-boy sequence. Doug writes of volcanoes, downpours, very friendly Indonesians, and a fascinating and enjoyable job. It sounds like fun.

The rest of the news this issue comes from Alumni Fund envelopes. **John Kershaw** notes that he's recently been appointed by Harris Corp. as program manager for their support of NASA's Space Station development effort. . . . **Leo Cardillo** sends the cryptic message that he and his family will conclude their assignment to West Africa in June 1985. . . . More news from afar. **Paul Gipslis** is with Aramco, where he is installing and supervising computer systems in the eastern part of the Kingdom of Saudi Arabia, and "enjoying it a lot." . . . On the entrepreneurial front, **Allan Press** is the president of a newly-formed company called Preventive Measures, Inc. The company creates and markets health-related software for medical and business professionals. I guess all Class of '64 people who went to medical school and became "real doctors" should consider signing on as Allen's customers. . . . The final news item is from **Bill Euerle**, who is still at Foxboro Co. but has changed jobs to become manager of System Special Projects. He is responsible for 16 engineers specializing in small-scale (that is, short time to market) development efforts. Bill has gotten heavily involved working as the Scoutmaster for his son's Boy Scout Troop.

Lastly, a message for all of you whom I spoke with at our 20th reunion: HELP! I cleverly took all kinds of notes and saved your business cards—and lost it all. The last six months have been spent looking, but I have finally given up. Please send a note telling me whatever it is you told me before. Thanks very much!—**Joe Kasper**, Secretary, 1100 Salem St., No. 103, Lynnfield, MA 01940

65 20th Reunion

I think that I may have figured out what happened to the columns. Last month was December, and as Anne and I were going through our informal year-end review of contributions, it struck me that I had received no Alumni Fund solicitation during the year. I have communicated that I prefer not to be solicited door-to-door or by telephone, and that may be all that the Fund is doing these days. In any case, I sent off a check in my own envelope, but that mechanism does not include the famous Fund envelope that is grist for the secretary's mill. I wonder how many classmates are having the same experience. It seems clear from my perspective that we either aren't giving, aren't including notes on the envelopes, or aren't being given the opportunity to send the envelopes. All but the third would be striking changes from previous years.

Patric Dawe sent a note that he is still a principal at community Design Group, an urban design and architecture firm in Pasadena. He reports that they do a combination of public sector urban design and private sector development master planning, and are associated with a firm doing high tech building and master planning. . . . **Tom Callahan** sent the month's other Fund envelope with a note that he is still running a computer and electronics company in Bangkok, Thailand. Wow!

Suzy and **Greg Schaffer** sent a copy of their long Christmas letter. Greg, as usual, lists an incredible assortment of athletic endeavors including triathalons, marathons, and shorter races. They started the year with Greg's triathalon on Kauai followed by a vacation on Maui and Kauai. (I wish I were there now.) Suzy writes about a September vacation in England and a cruise from Southampton to Miami on the *S.S. Norway*. Greg says that his firm was switching its line of business and phasing out his group as he wrote the letter. He expected to spend a few months consulting before joining another firm - probably a completed transition by the time you read this.

Well, if I can't get Fund envelopes, I need a column from somewhere. Please write to **Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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After seven years at MITRE, **Dave McMillan** has moved to GTE, where he is responsible for software development. He and his wife, Marilyn, who is on the M.I.T. staff, live in Winchester. . . . **Pat Confalone** is now a research supervisor in the Research and Development Department of DuPont. Prior to DuPont, he was in the Research Department at Hoffmann La Roche and has also taught at Rutgers. Pat received his M.S. and Ph.D. from Harvard. . . . **Michael Scott** is the author of a new book entitled *Computer Law*, published by Wiley Law Publications. . . . After living in the Boston area since graduation, **Donald Mattes** has moved to Silicon Valley where he is vice-president for distribution at Margaux Controls Corp. of San Jose, a manufacturer of energy controls for supermarkets. Don is delighted to hear from any classmates in the area. . . . In March 1984, **Fred Goldman** became a co-owner of San Francisco based Spot Systems, Inc., a company providing microcomputer based multi-currency accounting, foreign exchange, trading, money market trading, and loan/deposit systems to international banks and multi-national corporations. As a result, Fred has been doing a considerable amount of traveling, including a three-week stay in Hong Kong.—**Jim Swanson,** Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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Greetings again from the shores of the Potomac. If the words of this column seem more profound than usual it is probably because we have upgraded the Mac to a Fat Mac recently. See if you can tell the difference. Mike ran in the Marine Corps Marathon in November finishing in 4:34 and ahead of 1,200 others (but behind 7,600). It was an interesting experience. As the Japanese say, "A wise man climbs Mt. Fuji, a fool climbs it twice." So on with the news. . . . Our longest letter this month comes from **Michael Yokell**, so he will get front row treatment. Michael heads Energy and Resource Consultants, Inc. in Boulder, Colo., which has 20 full-time staff members including economists, engineers, and systems analysts. The firm continues to be a major provider of services in the area of environmental economics and modeling. Their study of the impacts of diesel particulate controls on air quality has received particular attention recently. . . . Another classmate-entrepreneur, **Bob Metcalfe**, made news at M.I.T. recently by giving the 'Tute $40,000 worth of stock in the firm he founded, 3Com, as a way of saying thanks to M.I.T. and the professors who taught him. He asked that the gift be earmarked for Project Athena, which focuses on the application of networked personal computers in education. If his good fortune continues, he would like to give more, such as a possible Metcalf Memorial Racket Sports and Computer Networking Center which would be painted green "to provide a home for those who wander M.I.T.'s campus looking for the Green Building."

Dan Harris has moved to the Naval Weapons Center at China Lake, Calif., where he is doing research in inorganic chemistry. . . . From Miami, **Paul Gluck** writes that he has a busy private practice in OB-GYN and is enjoying his family (son, 5, and daughter, 2) tennis, travel, and south Florida climate. He is also teaching and recently conducted a four-week symposium on "Medical Liability in OB-GYN." . . . **James Roberto** has been appointed technical assistant to the associate director for physical sciences at Oak Ridge National Laboratory. He previously was group leader of the plasma materials interactions group in the Solid State Division. After leaving M.I.T. he received M.S. and Ph.D. degrees in applied physics from Cornell. Jane and **James Catherine** live in Farragut, Tenn. and have two children.

Closer to M.I.T., **Jeffrey Tranen** has been promoted to vice-president of New England Power Co., where he is responsible for New England Electric's interest in nuclear generating facilities in New England. . . . **Ken Zwick** is with the U.S. Department of Justice as director of the Civil Division's Office of Litigation Support. Recently he had lunch with **Dave Cahn**, who is president of Database Applications, Inc., a Palo Alto software firm. . . . From Trumbell, Conn., **Hank Banach** reports that he has a daughter, 1, and a son, 5, and is purchasing manager at Norden Systems Division of United Technologies. . . . Finally Tim Johnson has left BBN Laboratories to join the General Electric Research and Development Center in Schenectady. . . . That's all we have for now; please keep those cards and letters coming.—**Gail** and **Mike Marcus**, 8026 Cypress Grove Ln., Cabin John, MD 20818

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Spring is in the air (a record 73 degrees F in Boston on December 29!), as I prepare these notes for your April enlightment. The pile of old notes has vanished with the snowdrifts.

Talal A. Kheir writes that he is still heavily involved in Oryx Systems Microcomputer Store and has opened a new store in London, England. He is interested in getting any feedback from "beavers out there" on microcomputing. . . . **Robert Sable** is now a physician specializing in internal medicine and gastroenterology in Riverdale, Bronx area. His wife Ellen and he are expecting their second child in May. . . . **Chris Brooks** has moved back to Pennsylvania where he is now director of Information Systems for Transamerica Delaval. . . . **Bruce Enders** is now corporate vice-president of the Major Appliance Marketing Division of the General Electric Co. in Fairfield, Conn. A fascinating article in the December 1984 *Esquire* chronicles the career of classmate, **Robert A. Swanson,** now the chief executive officer of Genentech, the San Francisco genetic engineering outfit he helped found. Genentech was first to develop a bioengineering technique for manufacturing human insulin. The article reports on how Bob's career went from chemical engineering back to M.I.T., to venture capital, and then on to genetic engineering with some of the leading scientists in the field. The article refers to Bob as "the first boy millionaire of biotech." Dream on you other would-be Earth-shakers!—**Eugene F. Mallove,** Secretary, 215 Highland St., Holliston, Mass. 01746

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Robert A. Dennis has been elected president of the Massachusetts Financial Services Co. Muncipal Bond Trust, which is a mutual fund with assets of $280 million. He was involved previously with the company in its fixed income department and as assistant vice-president and vice-president. . . . **J. O. Enwonwu** has developed the Niger Heritage Hotel in Nigeria and is principal consultant for Enwonwu Associates, which has architects, planners and engineers on its staff. . . . **Richard Lucash** is in private law practice. He specializes in computer law, after working for a computer law firm and a computer firm in Cambridge. . . . **Warren Davis,** who has worked on a control system for missiles, is a founder of High Technology Professionals for Peace, a group which objects to the "Star Wars" strategy.

Michael Prager received his Ph.D. from the University of Rhode Island in August and is now assistant professor of oceanography at Old Dominion University in Norfolk. . . . **Edward Devos** graduated from Harvard University with a Doctor of Education degree and has recently been the director of research and evaluation for the Massachusetts Office of Human Services. . . . **Reid Ashe** has joined Knight Ridder Newspapers, Inc., as a general executive and will be based at the company headquarters in Miami. He was former publisher of the Jackson, Tenn., *Sun*. He is chief executive officer of View Data Corp. of America, a video text subsidiary. . . . **Mary Thornton** is a correspondent/reporter with the *Washington Post*.. . . . **Frank Daurio** has left Hughes Aircraft after 12 years in order to join General Electric's Space Division of Military and Data Systems Organization in Valley Forge.—**Robert Vegeler,** Secretary, Dumas, Backs, Salin, and Vegeler, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

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Laurence Storch married Virgina Graves on September 20 in Alexandria, Va. . . . **Jim Shields** and Gayle Merling are expecting . . . **John Dieckman** and his wife Betsy, just had their second child, a girl. . . . **Dave Crary** and his wife, Ginny, are expecting in March. . . . **Kenneth R. Maser** has recently taken on a research appointment in the M.I.T. Department of Civil Engineering, where he is involved in development and instrumentation for maintenance and rehabilitation of elements of infrastructure. In his new capacity, he was awarded a grant from the National Science Foundation to research a technique for inspecting liners and barriers at hazardous waste sites. Dr. Maser is also founder and president of Civil and Environmental Technology Associates, a company specializing in commercial development of processes and equipment for Civil Engineering applications.

John Winters writes, "Our family now consists of Holly (5), Mike (2), and a new arrival expected January 8. Rebecca and I have been happily married since 1976. Since graduation I have worked for Raytheon Equipment Division, Documentation, Harris Controls Division. I am currently a systems analyst with ARK electronics products, inventing computer communication equipment. In 1975, I became a Jehovah's witness." . . . **Gordon E. Legge** spent the last academic year on sabbatical leave at the physiological laboratory in Cambridge, England. He is now back at the University of Minnesota. . . . **Barney C. Black** writes, "I have left Newport News shipbuilding to join S.M.A., Inc., a minority-owned computer manufacturer in Norfolk, Va. As a project engineer, I'll be helping modify their SNAP II computer system to go on the Los Angeles Class attack submarine." . . . **Lloyd Marks** was appointed assistant professor of pediatrics, division of pediatric cardiology, S.U.N.Y. Stony Brook, in October, 1983; in June, 1984, he was also appointed assistant professor of electrical engineering at S.U.N.Y. Stony Brook. . . . **David Spear** is working as a research engineer at Pratt and Whitney. . . . **Kenneth R. Woolling, Jr.,** has entered the Indiana University School of Law.

Nancy J. Rosenfield writes, "After a year of career turmoil, I am back at Data Resources (where I worked from 1977 to 1980), working as a software development project leader. I'm living in Lexington with my two children, Jennifer (10) and Todd (6), and my husband, Don, who is teaching at the Sloan School this year. He's on leave of absence from Arthur D. Little." . . . **Donald Feith**

and his wife expect their third child in January, 1985. Donald has started a new UNIX software distribution company, UXA Corp. . . . **Tsur Bernstein** has returned to Boston, and is working for ELSCINT, Inc., as a product manager of nuclear medicine. . . . **Adriana Bejan,** professor of mechanical engineering, has written a new book published by John Wiley and Sons, titled "Convection Heat Transfer." Dr. Bejan is the author of 90 technical articles as well as the graduate thermodynamics textbook, "Entropy Generation Through Heat and Fluid Flow." It snowed in south central Texas, my wife is expecting our third child and life is great. Please write.—**R. Hal Moorman,** P.O. Box 1808, Brenham, TX 77833

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We have a number of proud parents this issue, including **Darrell Rigel** and his wife, Beth, who are pleased to announce the birth of their son, Ethan Geldon, on February 22, 1984. . . . **William Scott** and his wife, Kathy Dollard, had their first child, Gregory Scott, on October 27. They see classmates **Chuck Hafemann** and **Frank Leathers** and their wives regularly, as well as other Sig Eps in the area. . . . Jill and **Carl Whittaker** had their first child recently—a son, Colin. Carl is currently a partner with Bain and Co. in Boston.

Several classmates have moved on to new jobs or positions, including **David Moregenlender,** who recently left his position as director of software development at the Saddlebrook Corp. to start his own business providing computer consulting services. . . . **Donald Hewitt** has left Storage Technology Corp. to pursue full-time consulting. Under the name Proconsul, he is providing specialized help for companies who sell A.D.P. equipment and services to the federal government. He is based in Alexandria, Va.

Richard Braun and his family have moved to America's heartland: specifically, Des Moines, Iowa. Lauren is in Montessori, Stephanie is in first grade, and Eileen will be teaching art. Richard is director of research and development for Frye Copysystems. Frye manufactures computer printer ribbons and carbon paper. . . . In September, **Joel Weisberg** was named assistant professor of physics and astronomy at Carleton College in Minnesota,. He had been an assistant professor at Princeton University and previously taught astronomy at the University of Massachusetts, after receiving M.S. and Ph.D. degrees from the University of Iowa.

Shirley Anne Wilson spent the last eight years as an instructor of mathematics at Auburn University at Montgomery. In September, she was appointed assistant professor of mathematics at North Central College in Naperville, Ill. She received an M.S. degree in mathematics at the University of Illinois in 1974 and is presently a candidate for the Ph.D. degree in secondary mathematic education at Auburn. . . . **Michael Rowny** has recently been promoted to senior vice-president, finance at M.C.I. Telecommunications, and he completed his first marathon—the Marine Corps Marathon—in November. He's still deciding which was the bigger feat.

Steve Edessin has been working at I.B.M. in Palo Alto since last December. He finds Palo Alto is nicer than San Jose and almost as nice as Berkeley. . . . **Phyllis Lantos** just closed the largest F.H.A. insured tax-exempt revenue bond issue, which is providing over $220 million for the rebuilding and equipping of Montefiore Medical Center. This is the culmination of more than three years of work with state and federal governments to process and receive approvals for this project.

Mark Norstein has definitely settled in St. Petersburg, Fla., with two beautiful children, Keith (4 1/2) and Melinda (2). His family practice is steadily growing. He hears from **Marty Leventhal,** Eric Shore, '73, **Jeff Cooper,** and Steve Grant, '70, all of whom are living in the Los Angeles area. . . . **George Greig** is a partner at a Philadelphia investment counseling firm, Pilgrim Baxter Hoyt and Greig, and has "moved to the suburbs with the mandatory two children—Liz and Laura—and two cars." Hope everyone has a great spring and sends news.—**Wendy Elaine Erb,** 531 Main St., Apt. 714, New York, NY 10044

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Carl Rosenberg "is now an academic, with pipe and sweater, working on eccentric." . . . **William Stohl** writes of a new offspring, Raphael, his third, born on May 14. William is finishing a fellowship in immunology at Rockefeller University.

Glenn Sharfin is still living in Ft. Lauderdale with his wife Phyllis and three kids, Andrea, Jackie, and Daniel. He recently passed his boards in orthopedic surgery. . . . **M. Kerry Simpson** writes that he and Linda are living in Mill Valley, Calif. Kerry is a senior consultant with Management Decision Systems in San Francisco. . . . **Charles Bryant** completed a joint program in urban design at U.C. Berkeley with master's degrees in city planning and urban design. He is with the City of Oakland as an urban designer and is in his second year as chair of the East Bay Bicycle Coalition.

Charles Allen Rhodes has been elected a fellow of the American College of Cardiology. Dr. Rhodes is with Sunrise Hospital in Las Vegas, Nev. . . . **David Mark** is a faculty member at Cornell Medical College. He and Jean have a daughter Rachel and son Daniel. . . . **Stephen Waller** and wife Jane are Air Force physicians at Wilford Hall Medical Center in San Antonio. They have two daughters, Katie and Jeanie. . . . **Debra Judelson,** M.D., is continuing full-time work in internal medicine and cardiology.

Tom Ellis recently became a senior staff engineer at Hughs Aircraft in California, where he managed to see several Olympic events this summer. . . . **Stephen Williams** reports on his first son, Nathaniel, born in October. The Williams family lives in Orinda, Calif., where Steve is with Bechtel.

Word from RPI is that two classmates were promoted, **Bruce Watson** to professor in geology, and **David Porush** to associate professor in language, literature, and communication. . . . **Roy T. Lydon,** a software development manager for Raytheon, designed and built a new home in Norwood, Mass., and announces yet another child, Edward (his third), born this past October.

Dana Roberts is doing research in theoretical astrophysics at Washington (Mo.) University. . . . **Doron Holzer** is financial systems manager at SOHIO as of October. . . . A letter came from **Doug Levene**. He finished clerking with Warren Burger, went trekking in Ladatch, then went to work in Hong Kong for Cleary, Gottlieb, Steen, and Hamilton. He is now in their New York office. He is engaged to Tracy Harris (U. of Maryland, '82) for a spring wedding.

On the home front, the family computer business is humming, and the Life Savers competed in March at the international preliminary competition of S.P.E.B.S.Q.S.A. in Scranton.—**Robert M. O. Sutton, Sr.,** Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Happy spring, fellow campers. I've gotta be in dance class in 70 minutes, so let's get on with it, shall we? First, from the Christmas card pile. Sue and **Steve Jordan** announce a newborn daughter, Caroline Denison. . . . **Liz Bagnall** is now **Liz Scarito,** working for FMC Corp. in Baltimore as a process engineer. . . . Beth and **Ken Green** are expecting their second in May. Of their first child, Aaron, Ken says, "The 'terrible twos' are only the first of a continuing series of stages ending in premature gray!" . . . **Steve Nuding** is in Washington, D.C., performing in a new musical called *The Beautiful Lady*. They hope to take it to New York, but they may go on the road with it first. Steve's stage name (equity rules, you know) is Stephen Craig. . . . Mary and **Joe Walkush** await their second, too, due late February. . . . **Jim Andrew** is "well and sane" at the Harvard Business School.

Don't forget to earmark your Alumni Fund contributions to the Class of 1974 Students Aid Fund. . . . Class Agent **David Shiang** just returned from the Far East on a marketing junket for Wang. He says: "Japan was exotic. Now it's cold!". . . **William Kupsky** is assistant professor of neuropathology at Columbia-Presbyterian Medical Center in New York. . . . From the newsclip service comes a notice that **David Tirrill** has joined the University of Massachusetts, Amherst Department of Polymer Science and Engineering. . . . Goody, Clancy and Associates, Inc., Architects announce the appointment of **Roger Goldstein** as associate. . . . **Douglas White** recently gave a presentation at the M.I.T. Sloan School on the design of low-cost speech synthesizers, along with a live demo of same. . . . **Bruce Schobel**'s work for the Social Security Administration sent him to Liberia for a month last summer and St. Lucia for two weeks in December. Actually, that could have been summer and December 1983 respectfully, with the way news travels around here. Son Michael was 1 in February (1985). . . . **Jose Rodal** has been appointed director of research and development for Beloit Manhattan, Inc., Clarks Summit, Pa.

Last but not least department: Got a long letter from **Greg Turner**. Here are the highlights. After leaving Johnson/Burgee, Architects in New York, Greg joined CRS Sirrine, Inc. in Houston. After over three years there, Greg has established his own architectural practice in Houston. The going has been tough since the office building market is saturated presently, but he is plenty busy and feels the long-range prospects for Houston and Texas are excellent. Greg married Ann over two years ago, and Matthew John turned 1 in February. Greg writes, "All three of us are doing well. I am going to have to design a lot of buildings between now and 2001 (his freshman year) to be able to afford his education at M.I.T.!" Yeah, Greg, and rob a few banks.

Well, I've 20 minutes to make that dance class. I'm riding my ten-year-old BMW motorcycle cross-country to Salt Lake City in May. I'd sure appreciate invites from classmates for an overnight stay, especially in those *long* states like Kansas and Iowa. Write me.—Co-secretaries, **Lionel Goulet,** 21 Melville Ave., Dorchester, MA 02124; **Jim Gokhale,** 45 Hillcrest St., Arlington, MA 02174

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The mails have been kind for this issue of notes. . . . From **Sheri Abrams,** "A promotion! Hardware project manager at Hewlett-Packard." . . . **Fred S. Tsuchiya** is currently developing a multi-kilowatt laser welding robotic system for Advanced Technology Division of MTS Systems Corp. . . . And **Michelle Petrofes** is "currently working on the Navajo Indian Reservation as a family practitioner at Sage Memorial Hospital, Ganado, Ariz. Married April 1983 to Dale Harris during family practice residency, at the University of California, Davies."

Ben Szaro has recently moved to the Washington, D.C. area after taking a staff fellowship at the National Institute of Child Health and Human Development. . . . **David Silberstein** is currently supervisor, Regulatory Affairs at Westwood Pharmaceuticals (a division of Bristol-Myers) in Buffalo, N.Y. His second daughter, Stephanie Rose, was born on October 5, 1984. . . . **Neil Kaden** is the manager, DMS Data Communications Development, as well as New Product Opportunity Studies, at BNR in Richardson, Tex. Also acting as the lab's liasion to M.I.T., we managed to quadruple the number of M.I.T. grads here in the last year—up from just me! Even got us a two-page ad in the College Placement Guide.

Two letters from **Jerry Dausman**! he writes, "My firm sent me to Sacramento, Calif. (from Washington, D.C). As long as I was going out, I made the effort to look up fellow classmate **Stuart Morgan** and stay with him for a couple of days. Stuart lives in San Francisco. As it was my first trip to that beautiful city, Stu and I went everywhere and saw everything. Stu is doing well as a licensed architect in a small, 30-person firm." Jerry resumes with a note about his defense of his U.S.A. Monopoly championship title: "In case you haven't heard by now, I'm no longer the U.S. Monopoly champion! I managed to get Boardwalk and Park Place, about put three houses on each, but no one landed on them for the rest of the game! Highly improbable—but them's the breaks. We really enjoyed Beverly Hills, though I just hope my wife doesn't expect that kind of luxury all the time!"

Your secretary received a lovely Christmas card from **Stan Knudsen**. He wrote the verse and designed the layout. Stan has joined the set of householders, buying a place in N. Reading, near Lowell, Mass. His firm, Digital Automation, is flourishing, I am pleased to report. Also flourishing, at this juncture, is **Dan Dershowitz,** spouse Debbi Gross, '78, and son Michael.

As for your secretary, he, too, is flourishing a bit. By the time you read this (it being early January), I will probably be consulting as a monetary/bond market economist to an investment firm. If this moves forward as I anticipate, it could be very interesting. I am also interested in looking at start-up business ventures, as I am sure many of you are as well. If you have any ideas, I'd be interested in hearing about them. Insofar as the markets are concerned, my bullishness in bonds (lower rates) has paid off somewhat, with the best possibly yet to come. The dollar has put in an amazing performance against everything else, showing muscle which may best be described as Herculean. And, of course, precious metals and oil have contributed to the excitement induced by dollar strength. Please do write—we need the news.—**Arthur J. Carp,** Secretary, 110-07 73rd Rd., Forest Hills, NY 11375, (718) 544-5136

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Donald Rediker has returned to New England from Palo Alto. Donald is presently a cardiology fellow at Massachusetts General Hospital, and is living in Watertown. . . . **Daniel R. Higgins** will be completing his general surgical residency in Philadelphia in July, and then returning to join the Palm Beach Medical group in West Palm Beach. . . . **Jeffrey Young** has left the Massachusetts Office of Transportation and Construction to join Macomber Development Associates, a real estate development company. Jeff has recently had lunch with Al Chock, '78, who works in the same building. Jeff says hello to the gang from NRSA, and give him a call if you're in town.

Deborah Hoover Dobson is still with the Subsea Systems Section of Exxon Production Research. Their two sons are growing fast, and the oldest enters kindergarten in September. . . . Dr. **Renan Beckman Wills** is now a resident in anesthesiology and critical care medicine at Johns Hopkins Hospital. Renan is enjoying living in Baltimore, renovating an old row house with the assistance of her husband, who is in his surgical residency. . . . **Esther Horwich** is keeping busy with her law practice (including practicing before the U.S. Supreme Court) and her musical affiliations. Esther is playing in two orchestras and a symphonic band, and is planning to go to Bonnaire this winter to go scuba diving.

Alexander Nedzel is now a senior associate at Index Systems, Inc. Alexander and his wife are expecting their first child in January, . . . **Ron and Linda Pirek** are the proud parents of their first child, Curtis Stefan, born November 4, 1984. Ron has moved up to group leader dealing with irradiation effects on reactor pressure vessels in the system materials group at Combustion Engineering. . . . **Randy Perez** is working for CIBA-GEIGY's pharmaceutical division in Summit, N.J. Randy occasionally sees **Mike Saks, Barbara Thornton,** and **Rich Smiley**, "but not as often as we'd like."

Dave Dobos sent a nice long Christmas letter, describing his career changes at Accuray, and other activities. Dave has jumped from the financial/administration side of the business to the product side, and is thoroughly enjoying learning this part of the business. Dave is working on the Columbus, Ohio public schools advisory council, and was approached to fill a Board of Education position recently. Dave turned it down due to heavy travel commitments at Accuray, but remains involved. Dave is also active in community and neighborhood development groups, interviewing prospective M.I.T. students, and being a big brother in the Big Brothers' program. In the warmer months, Dave can still approach a five-minute mile, and competes in the corporate challenge competitions in the area.

Mark, '76, and I continue to enjoy life in the high country, and hope you'll call or stop by if you're in the area.—**Barbara Wilson Crane,** Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Francis Scovil writes that she is finishing up her last year of business school at the University of Chicago. For her summer job, she'll work as a supply analyst for Mobil Oil in New York City. Then in August, she'll go to Barcelona, Spain, for a full quarter of studying there. And then, back to Chicago for her last quarter and to find a job. In Francis' words: "Am looking forward to a 'moving' year (har, har)." . . . "It's impossible to find a boring postcard in Switzerland," **Sue Kayton** wrote on her quite beautiful postcard from the Alps. "I highly recommend it since it's clean, the people are very friendly, and the chocolate is great. Nothing new, except I found an 'in' with Hughes Aircraft to get scholarships for entering M.I.T. students (but they won't pay off my student loans)." . . . The postcard **Janet Freeman** sent me is indeed boring. (The Mt. Vernon Inn, Escondido, Calif.) Janet got her master's in Aeronautics from Caltech last June, and then re-enlisted for another year for an aeronautical engineering degree. Janet's "significant other," Mike Smith, is a graduate student in organic chemistry at Caltech. . . . **Mike Geselowitz** and **Rich Zingarelli** sent me "the most boring postcard we'd ever seen" from Seattle (but unfortunately, I had it already). Mike and Zingo were out there for the wedding of Dave Heller, '79.

A card from Dan ('77), Catherine Rhea ('03?), and **Teresa Nolet** informs us that Catherine is expecting a younger sibling. Catherine's parents are still working in the Corning, N.Y. area. . . . Another fraternity brother of mine, **Pete Shaw** tells me that we just received yet another fraternity niece: Pete's wife Kathie gave birth to Allison this winter. When not parenting, both are post-docs at Woods Hole Oceanographic Institute, along with Pete's and my former roommate **Spahr Webb**. . . . I ran into **Debbie Kaden** in a grocery store in Central Square. Debbie moved back up here after two years of post-doctoral study at N.Y.U. Now she's a post-doc at Boston's Dana Farber Cancer Institute, and she expects her first child in April. . . . **Paul Malchodi** chose winter as the time to return from balmy Florida to frigid New England. G.E. transfered Paul from Orlando to its Lynn facility. Last I heard, he was living in the Holiday Inn in Peabody, Mass., looking for more permanent shelter. . . . **Jerry Epstein** writes to update us on his latest doings. When we last saw our struggling hero, Jerry was getting his Ph.D. in physics at the University of California at Berkeley. "If Berkeley bureaucracy functioned at all, the degree was actually awarded in May, 1984; I won't know for sure until I receive my diploma in early 1985. After finishing at Berkeley, I spent a year as a congressional fellow with the U.S. Congress Office of Technology Assessment and am now on O.T.A.'s permanent staff. I am working in the International Security and Commerce Program on an assessment of new ballistic missile defense technologies (which is how 'Star Wars' translates into governmentese). It is quite a change, switching my focus from the Big Bang to cosmologically insignificant but personally non-trivial Little Bangs. O.T.A. is an exciting place to be, and it's nice to be living in a region where the trees don't have to guess what season it is. I am looking forward to my first autumn since leaving M.I.T."

Look out, D.C.: **Sue Ann Hanson** says, "Still alive here in D.C. Have been a hermit for the last six months—will be changing that soon!" . . . **Peter Woodbury** has come back to bean-town looking to ply his new skills with his University of Virginia M.B.A. . . . Class agent **David Woodruff** was recently appointed a liaison officer for M.I.T.'s Industrial Liaison Program. . . . From **John Camperman:** "After six years as an educator, finishing as an assistant professor and division head of oceanographic technology, I have just taken on a new position as configuration manager of the MK12 Diving System for the U.S. Navy." . . . A note from **Mark Tannen** informs us that he is publishing a new software package for the Apple Macintosh. He calls it MACFATS, a film, advertising and television system, consisting of storyboarder, scriptwriter, production planner, budget planner, contracts, talent, travel, and directory/calander modules. Mark is chairman and chief executive officer of the American Intelligence Corp., located in Marina Del Rey, Calif. . . . As for me, my personal life continues to be blissful—especially since we found some new local bridge players at about our level. My professional life, however, recently changed from wonderful to major headaches. Details next month. Send news, mail, lies, and boring postcards!—**David S. Browne,** Secretary, 50 Follen St., Apt. 104, Cambridge, MA 02138

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Gail Kaiser is expecting her Ph.D. in computer science from Carnegie-Mellon University this summer and is looking for a job. . . . **Jay Ericson** is enjoying his second year of general surgery at Brigham and Women's Hospital in Boston. . . . **Emerson Knowles** was married in 1982 to Karen Hoving, and is now the proud papa of a baby girl, born January 14, 1984. He enjoys his work in Cincinnati. . . . **James Thompson,** wife Joyce, and son Charlie are living in Pittsburgh, where Jim is an architect with Martin Cheltin Associates.

Christiane Tellefsen graduated from the Univeristy of Illinois College of Medicine in June, 1983, and is now a resident in psychiatry at the Univerity of Maryland Hospital in Baltimore. . . . **Aaron Endelman** is "happily ensconced in sunny California, hacking LISP for Symbolics. Leisure activities include drama, music, and soaring." . . . **Michael Tarsi** recently attended **Ken Calvert**'s wedding in Knoxville, Tenn. Ken is at the University of Texas, Austin. Michael has recently joined Silicon Design Labs, a semiconductor start-up in New Jersey. He writes, "Small, young companies are busy but fun." . . . **Mark Schuetz** and wife Veronica (Smith, '79) had a daughter, Giselle Brianceschi, on October 8, 1983. They are living in Granville, Ohio.

Tim Carroll is "a post-doc research associate in astrophysics and am happily rowing on the Thames River for the University." (He doesn't say which university, but I think it's safe to assume that it's somewhere in London.) . . . **Susan Jane (Morris) Colley** is still at Oberlin College. She writes, "Will and I bought a house and another cat. Working on a pet beaver!" . . . **Kate (Malcolm) Stohlman** and husband Tom, '76, are "the proud, ecstatic parents of Olive Remington Stohlman, a happy baby girl. I'll return to Hewlett-Packard in Andover when I get over the shock!"

. . . **Dave Westenberg** continues to enjoy married life and his high-tech corporate law practice at Hale and Dorr in Boston.

That's all for now. Please write soon.—**Sharon Lowenheim,** Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

80 5th Reunion

Greetings, classmates! Well, it looks like my European travels have come to an end. I am once more settled in the Boston area, and back to serious business of writing class notes columns.

Kicking off this column is a long letter from **Tom Griffin** to my fellow correspondent, **Debe Utko**. Tom wrote in September amidst a stint with the Navy. He was on the *U.S.S. Arkansas* in the Pacific and Indian Oceans for about six months. His job in the engineering department there included responsibility for controls over water chemistry and radiology in the propulsion spaces. Tom's big news is his wedding, which will have taken place by the time this sees print. Tom and Chris Rockwell (Simmons, '81) plan to be married on February 2, 1985. From there, they will be moving to Washington state, and then to the San Francisco area. Tom's navy commitments, lasting for at least another year, are keeping him moving. . . . Tom also reports that friend **John Dolan** is doing well working for Exxon Research and Engineering. He has purchased a co-op in Morristown, N.J.

Susan Lee has been appointed a liaison officer for M.I.T.'s Industrial Liaison Program. Susan starts her new job after having spent time as a development engineer with Church and Dwight Co., Inc. . . . I had the opportunity to talk to **Kevin Wallace** recently. Kevin is working for the Computer Systems Division of Hewlett-Packard in Cupertino, Calif. . . . **Alison (Carmichael) Saylor** is now a manager at Digital Equipment Corp. She has a two-year-old daughter, and she reports that she and Mike are still "living happily ever after."

Peter Lemme was married on April 28, 1984 to Julie Montgomery. Turning out for the big event were **Mark Vershel, Mark Zaretsky, Dean Phillips, Ricardo Sitchin, George Caan,** Bill Flarsheim, '81, and Julie Foster, '83. Peter and Julie are living in Seattle and are both working for Boeing. . . . **Mark Vershel** is working for Intel, near San Francisco. Mark has recently purchased a Masda RX-7 and can be seen tearing up the highway in his new car. . . . **Mark Zaretsky** was working for Kodak in Rochester, N.Y. This past fall he returned to M.I.T. to work on his Ph.D. . . . **Ricardo Sitchin** is living in Salt Lake City and working for Chevron. He is working a different shift each week, so he busily searches the city for drinking establishments that can match his lifestyle. He has also managed to go on a date with three Playmates! (Is that one date with all three, Ricardo, or three separate dates? Oh, heck, I'll just wait for the memoirs to come out.) . . . **Dean Phillips** is still self-employed with his brother in Norwalk, Conn. They are currently marketing software to aid political campaigns. People watching the newspapers in the Connecticut area can occasionally catch an article about the entrepreneur exploits of Dean and his brother. . . . **George Caan** is working for the city of Boston, and attending Northeastern University at night, working towards an M.B.A. Thanks loads to Peter for all of this gossip.

Sai Leong is currently attending night classes for an M.B.A. at the University of Chicago's Graduate School of Business. . . . **Paul Homsy** is enjoying his first year as a surgical resident at St. Josephs Hospital in Houston. He visited Boston in November and visited **Jeff Watiker** and his wife, **Martin Prince,** and Jerry Stringham, '81, who are at Harvard Law, Harvard Medical, and Harvard Business schools, respectively. . . . **Christopher Dunn** has moved to North Carolina and is pursuing an M.B.A. at Duke's School of Business, and is enjoying life in the south. Captain **James Buckingham** has graduated from the army's engineer officer advanced course at Fort Belvoir, Va. . . . **John Dieken** is working on his S.M. in mechanical engineering at M.I.T.

Most of you have probably received a letter form the Class of 1980 5th Reunion Gift Chairman, **Charlie Yie**. Charlie has asked me to remind the class of some of the salient goals of the fund-raising campaign. These are: (1) to have 55 percent of the class making a gift between now and June 30, 1985; (2) to have 70 percent of our class making at least one gift to the Alumni Fund since graduation; and (3) to establish an endowed "Class of '80 Student Aid Fund," for which $50,000 must be raised by our 10th reunion. In addition to what we contribute, the Class of 1930 has offered to match, on a two for one basis, any increase in gift that is $25 or more over last year's gift! I would like to urge everyone to please give, and give generously, so that others may have the same opportunity that we all had.

Last, and certainly not least, I would like to plug our upcoming 5th reunion. By the time you read this, the reunion will be just a few months away. It will be held June 6-9 at M.I.T. The reunion activities include a Tech Night at the Boston Pops, a Technology Day Program, a whale watch cruise, and other events. Most of all, however, it will give us all an opportunity to catch up with old friends and classmates, and to see how the Tute has changed in the last five years. I'll be looking forward to seeing a lot of my friends there, and I hope that many of you will be able to make it.—**Ken Turkewitz,** Secretary, 11 Academy St., Arlington, MA 02174, (617) 641-4495

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Michael Rakijas started a new job with Martin Marietta Aerospace in Baltimore last September. By the time you read this, Michael will have been married to Leslie E. Derman, an American University graduate, for a month. . . . **Eric Whitaker** will be attending air traffic control radar school in Oklahoma City. . . . **David McCelland** is a U.S.A.F. pilot, flying C-130s at Pope AFB. . . . **William Uhle** is currently stationed at Shaw AFB, S.C., and is a member of 19th Tactical Fighter Squadron, flying F16s.

John Maciulewski was recently transferred to the Commercial Loan Accounting Department at the Connecticut Bank and Trust Co., in Hartford. . . . **Peter Schneider** is now at National Rolling Mills in Malvern, Penn., as quality control manager. . . . **Victor Miller** works for Loral Electronic Systems as a systems analyst.

Bill Chambers is moving back into "the beautiful city of Boston" to work at Medical Electronics Corp. . . **Tim Cleary** is still "making candy" at M & M/Mars, where he was recently promoted to senior design engineer. . . . **Guy Vachon** sends us some good news: The lastest addition to his family was a boy, Guy Pierre, born July 2, 1984. Guy is currently working as senior development engineer in future acquisition systems with Schlumberger.

John Bisognano is a Ph.D. student in chemistry at S.U.N.Y. Binghamton. . . . **Jon Colton** writes that he is "still at M.I.T. trying to get out before they give me tenure as a grad student." . . . **F. Andrew Woel** is now a graduate student in chemical engineering at the University of Minnesota.

Mark Fogel describes a picture of medical school different from the usual. Mark's last year in medical school has been split between "galavanting around the country, looking for internal medicine residency programs and having a really enjoyable time up at school, partying, and learning without much pressure. Mark adds that he plans to do a lot of downhill skiing this winter and has been playing all the I.M. sports and running 10 K. races." . . . Received a nice postcard from **Nora Dudziak** sporting a picture of "Ted's Sales Room." (You had to be there.) Norm is a component engineer at General Dynamics in Groton, Conn., working mostly on submarines. Norm's hobby is folk dancing. He dances with a group that does Old English dances (over 400 years old) that were originally pagan fertility rites. . . . **Robert Schoenberger** writes that he is still "hobbling around with my leg in a cast after a fencing injury."

As for yours truly, the counsulting life at Bain keeps me busy. Please feel free to call if you're ever in town. But in the meantime, write!—**Charles Markham,** Secretary, 362 Commonwealth Ave., Apt. 2E, Boston, MA 02115

82

Hello classmates. **Bill Ralston** graduated last year with a master's in electrical engineering from the University of Southern California. He's working at Rockwell-Collins, where he started after graduating from M.I.T. Bill's been promoted to "lead engineer" directing the work of five engineers in developing software for a satellite modem. . . . Postcard of the month goes to **Michael Post** for his novelty of a fountain decorated with a life-size plastic jumping swordfish. (Somehow, I think that my written descriptions just cannot capture the wonder and beauty of some of the postcards I receive.) Mike went on a cruise of the Caribbean last fall, won $150 playing blackjack, and then proceeded to lose it the following night. Mike's living in a four-bedroom townhouse in Virginia Beach. Sounds pretty nice, Mike. I'm just happy to have a four-walled room. Who are you planning on keeping in the other three bedrooms?

Mike Colucci finished up his master's in chemical engineering last year at the University of Texas at Austin. He's working at Dow in four three-month assignments. The first was in Central Research working on reverse osmosis membranes. Last year, Mike spent six weeks traveling in the People's Republic of China and in Thailand visiting Mark Radka, '81, who is there in the Peace Corps. He also visited **Ed Maxwell** in Seattle. Ed's working there for Boeing. Mike was wondering what's happened to **Jim Olivio, Bruce Entwistle,** and **Howard Huber**. Does anybody out there know?

Tanya Sienko is working on her master's in electronic engineering at the University of Tokyo. . . . **Rainer Brusch** received his Ph.D. in engineering at Berlin Technical University in Germany and is now working as executive assistant (export marketing) for Standard Elektrik Lorenz Ag., a subsidiary of ITT. . . . Stuart Anderson, '81, and Brenda McDonough, '83, plan to be married in September. They took the average of their class years and decided to break the news in my column. (Eat your hearts out, Chuck and John. . . . Just some friendly class secretary rivalry.) Anyway, I knew them from my brief, my memorable, days in Student House. Also, they visited a bunch of other "Studs" last Christmas in Silicon Valley. Included were **Scott Robins, Will Gaherty, Rachel Cotter,** and **Calvin Stubbins**. Stuart and Brenda are both working at GA Technologies in San Diego. Congratulations!

John Jay McCauley is working at Combustion Engineering in New Orleans. He was married last year to Marcie. (John didn't mention Marcie's last name.) Congratulations to you! . . . **Robert Sawyer** is working in Kendall Square consulting in AI systems. . . . **Gontran Kenwood** is working for Hitachi in Yokohama under the M.I.T. Japan Science and Technology Program. Sounds exciting, Gontran! . . . **Dave Kushner** is in his third year at Case Western Reserve Medical School. . . . **Russell Murphy** made it to the World Lightweight Rowing Championships in Montreal last summer. . . . **Thomas Piccone** is working on his doctorate at Drexel University in Philadelphia.

I'm living happily in Cambridge with my two cats. The cats really enjoy reading your letters, so even if you don't want to write to me, you should be keeping in mind the happiness and emotional well-being of my kitties (not to mention the rest of the class). Write soon! Take care.—**Rhonda Peck,** 38 Bigelow St., Cambridge, MA 02139

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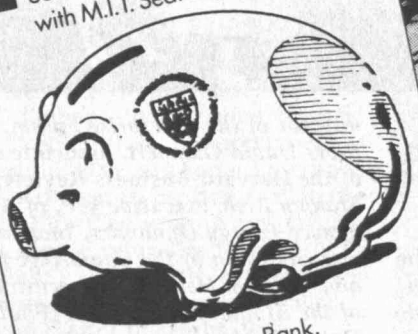

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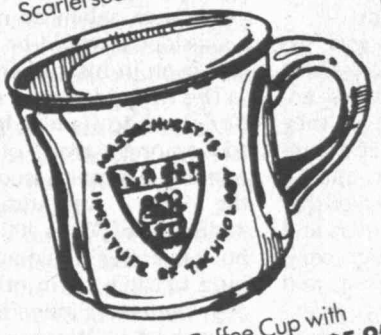

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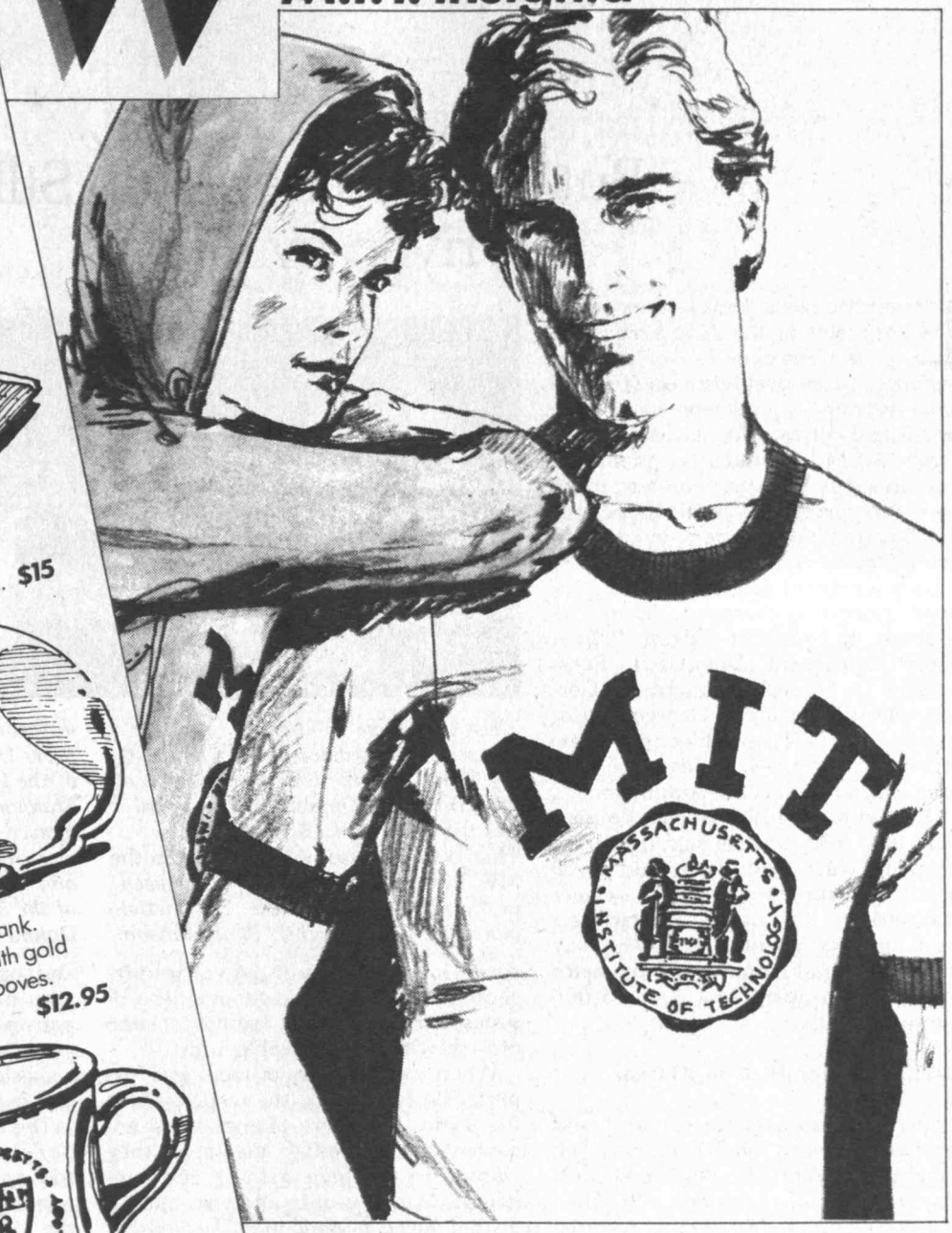

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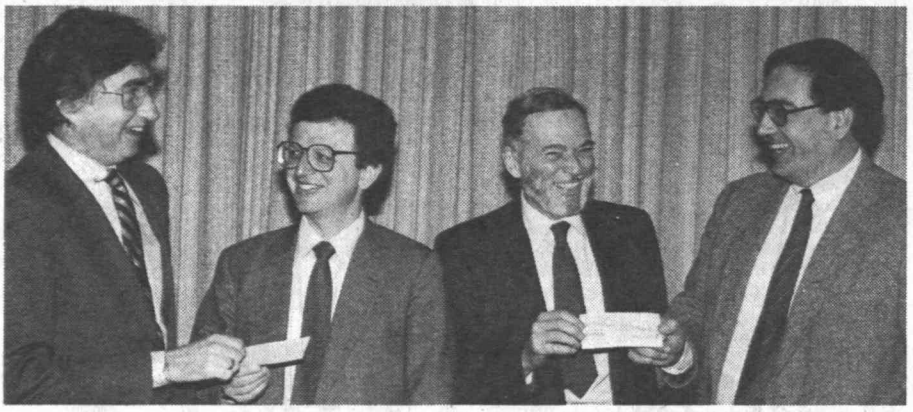
Investment Slow, But Entrepreneurship Still Driven by vision

Everyone has a dream—the city editor's slot at the *New York Times* . . . a classroom full of devoted students . . . an oval office on Pennsylvania Avenue . . . innkeeper in a South-Seas-island retreat. For an astonishing number of M.I.T. students and alumni that dream is entrepreneurship: to be free—and successful—as the founder of a company that prospers by making technology work for people.

Their fervor is intense, their heros revered: Robert A. Swanson, '69, of Genentech, Kenneth H. Olsen, '50, of Digital Equipment, Douglas T. Ross, S.M.'54, of SofTech, Bernard M. Gordon, '48, of Analogic, George Hatsopoulos, '49, of ThermoElectron, Alexander d'Arbeloff, '49, of Teradyne, Philippe Villers, S.M.'60, of Automatix . . .

Queried for the *1984 Alumni Register*, more than 5,000 alumni said they were company chief executives, and 3,000 more listed entrepreneurship as a career goal. Indeed, the business of starting a company and making it successful may be the strongest common denominator yet found among M.I.T.'s 75,000 alumni.



These men have good cause to be pleased. The occasion is the "reinvesting" back into the Enterprise Forum of a portion of the prepublication royalties from the book, **Business Plans That Win $: Lessons Learned from the MIT Enterprise Forum,** *to be released in May by Harper & Row. The participants are (left to right): Paul Johnson, director of the Enterprise Forum; authors David Gumpert, associate editor of the* **Harvard Business Review,** *and Stanley Rich, executive V.P. of Advanced Energy Dynamics, Inc., and former chairman of the Cambridge forum; and William Hecht, '61, executive V.P. of the Alumni Association. (Photo: Donna Paul)*

Magnet for Hundreds of Alumni

Suspecting this common interest and seeking to serve it, John W. Jenkins, '43, Loughrey R. Kuhn, '67, William D. Putt, '59, Frederick G. Lehmann, '51 (then vice-president of the Alumni Association), and a few colleagues joined in the early 1970s to run a series of workshops in Cambridge to help alumni who had good technical ideas and wanted to start their own companies. Their special goal was to bring to those who needed them most the findings of Professor Edward B. Roberts, '57, of the Sloan School. Roberts had studied the M.I.T. "spin-offs" along Route 128, trying to determine who succeeded and who didn't, what worked and what didn't, and why.

The workshops were popular beyond expectations. They were a magnet for hundreds of alumni who had launched themselves in business or wanted to do so, from one-boss-and-two-helpers shops in basements and garages to hard-pressed partnerships trying to keep growth within manageable limits.

When the workshop idea was exported to New York, the response was the same. But there alumni were not content with one-day meetings: they wanted to continue helping entrepreneurs succeed, year in and year out. To do that they conceived in 1973 a monthly "venture clinic," at which dreamers and funders of small high-technology companies could present their plans and problems. A panel of volunteer experts—and the audience, too—would respond with advice and comments.

That kind of exposure takes courage—every detail and every problem of a new enterprise has to be put on the table, and the critics can be ruthless. But the chance for free advice, "networking," and the stimulation of a clinic appearance were compelling. The M.I.T. Enterprise Forum of New York has now helped at least 200 entrepreneurs understand and deal with their problems and opportunities. (One entrepreneur who made a presentation of his company plan found the help he needed two years later, when he met by chance on a ski slope a would-be collaborator who had been in his audience.)

The clinic idea soon spread from New York back to Cambridge, where it took root among a group of volunteers as an ongoing Alumni Association project. By the 1980s it was attracting Cambridge audiences of 300 to 400 a month for two-hour evening sessions. Now it's beginning to catch on in other high-technology centers. Pioneering groups were launched in Washington/Baltimore, then Chicago, Miami, the Los Angeles area (in cooperation with Caltech), Houston, and Seattle. This year initial sessions of venture clinics have been held in Denver and Philadelphia. There are 2,500 subscribers to the Cambridge Enterprise Forum's monthly newsletter, 2,000 to the Washington group's announcements, and upwards of 1,000 each to those in Chicago, Houston, and Miami. The entrepreneurship/venture

clinic movement is now a major thrust of M.I.T. alumni activities.

Annual one-day workshops on planning, financing, and operating new businesses have been a popular feature of the Enterprise Forum activities in Cambridge for the past five years, and the third in a similar workshop series will be held in Washington this spring. Indeed, nearly 600 registrants attended the 1984 program in Cambridge—"Building a Quality Control Company".

Stock Market Far Less Bullish

Can this kind of popularity be sustained? Perhaps the dizzying upward spiral of interest in entrepreneurship will slow in 1985, say some Enterprise Forum participants, but don't call in the first-aid team. The venture capital business is simply returning to what Norman Fast, president of Venture Economics, says is a more "realistic" pace than that of the early 1980s.

Changes in the capital gains tax in the late 1970s and early 1980s precipitated an "astronomical increase in new commitments"—a level of activity that simply cannot be maintained, Fast told a Cambridge Enterprise Forum audience early this year. The stock market is far less bullish now about venture capital companies, euphoric visions of quick profits are being replaced by more sensible ones—a cyclical downturn that may have been overdue.

Only one cloud on the horizon could push entrepreneurship back into the "dark ages" of the early 1970s, Fast thinks: a change in tax laws that ends the favorable income-tax treatment now given to capital gains.

Paul E. Johnson, the first full-time coordinator for the Alumni Association's many Enterprise Fourm activities, is optimistic. Those who make the leap into entrepreneurship have a faith that adversity cannot dim—faith that successful small companies are the only sure wellspring for the technological innovations on which America depends for future prosperity.—*John Matill* □

Taking on Giants in Mobile Communications

BY CAROL SMITH MONKMAN

The scene had all the ingredients of a game show—an eager panel, a nervous contestant, and an audience primed for action.

But the setting was the auditorium of the Rainier Tower in Seattle, and the occasion was the first of half a dozen M.I.T. Enterprise Forums to be held in this area. At stake were the future plans of Stephens Engineering of Mountlake Terrace.

"Being dissected is somewhat painful, even when you volunteer," said a cheerful but intense David Thompson, Stephens chief executive officer.

Stephens, which was founded eight years ago by three engineers, is a $3-million-a-year company with about 50 employees. It designs, manufactures, and markets single-sideband, high-frequency radio equipment for marine applications.

Recognizing the problems inherent in relying on one product line, the company invested heavily in engineering research to break into the $1.5-billion market for land mobile communications equipment. Because the airwaves for such communications are already congested, Stephens' effort focused on narrowband or "spectrum-efficient" technology to provide more channels within the same number of frequencies. But that technology, referred to as ACSB, has not yet been authorized by the Federal Communications Commission.

That's not Stephens' only problem. In going from being a major player in a small market to being a very tiny player in a monstrous market, it takes on some monstrous competition—Motorola, for example.

Public Offering Aborted

Further, when a $3.5-million public offering was aborted last spring (the underwriter was shut down by the National Association of Securities Dealers), Stephens lost the money it needed to ante up for the next round.

That's why it bared its soul to the M.I.T. Enterprise Forum.

The first issue addressed by the panel was the lack of balance and depth in the company's board of directors. Jim Woodward, a Boston-based banker with experience in high-tech finances, recommended beefing up marketing and finance expertise on the company's board. That might have averted the problems with the underwriter that went under, he suggested.

The company could also benefit from a board member who has the marketing finesse required to compete against a monolith like IBM or Motorola. "I'm not sure (Stephens) understands how tough it is," Woodward said.

Dale Hatfield, a communications consultant from Washington, D.C., that unless companies are pressured by the FCC to use the new ACSB technology, it's quite likely they won't. He recommended that Stephens invest in some hard lobbying.

Assuming regulatory support comes through, Stephens is still left with the task of competing in a vast market with limited resources. Allen Frazier, vice-president of Immunex, the Seattle-based biotechnology company, said that his firm sidestepped the problem by going into joint ventures with major pharmaceutical companies. Immunex stuck to R&D, leaving the marketing and manufacturing to companies that are set up to do it efficiently. Frazier urged Stephens to do the same.

David Thompson, who appeared braced for the worst throughout the two-hour ordeal, looked relieved when it was all over. "Little companies tend to become self-fulfilling prophecies," he said. "But we can't walk around telling ourselves what a great job we've done forever." □

Condensed with permission from an article in the October 29, 1985 Bellevue, Washington Journal-American.

Alumni Do It All: Counselling, Sports, Supporting Entrepreneurs

Victory Is Sweet

It took 10 years, but the "has beens" finally beat the youngsters in the 12th annual M.I.T. Alumni-Varsity track meet held December 15 in the Athletics Center. The final score was 57 1/2 to 55 1/2 in favor of the graduates.

The alumni captured nine of 13 events, including all six field events, with Brian Moore '73, Dave Wilson '73, Jason Tong '79, and Paul Neves '83, each winning two events. Moore, competing for the first time since 1981, won the 35-lb. weight throw with a toss of 57'10" for a new facility record. He also captured the shot put (46'3").

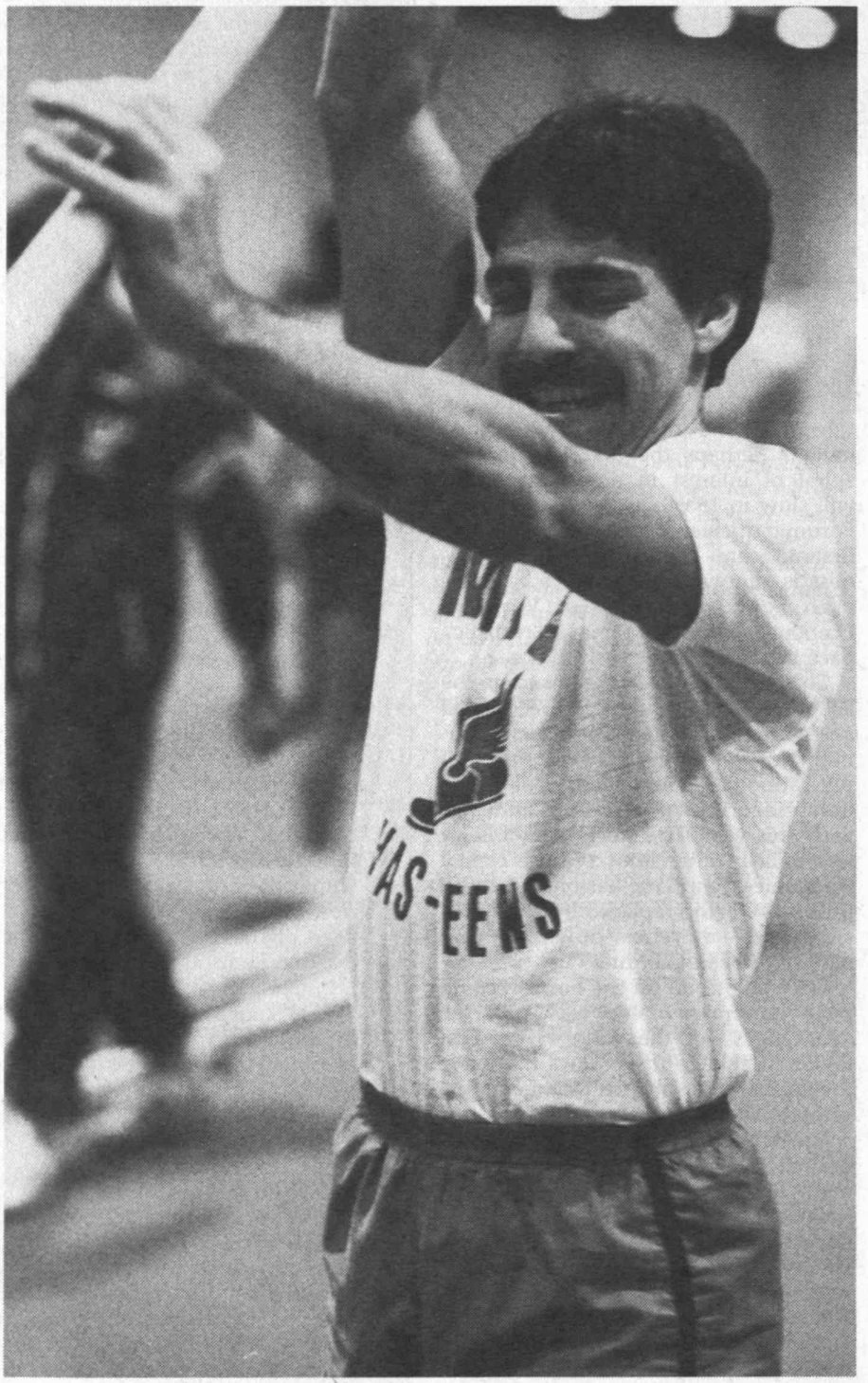
Wilson, a member of the M.I.T. Corporation and Visiting Committee on Athletics, won the pole vault for the 12th consecutive time (14'0") and also captured the long jump (20'6 1/2"). Tong, meanwhile, won both the triple jump (42'10 1/4") and high jump (6'6") while Neves was victorious in both the 800 (1:57.60) and 1500-meter (4:01.05) runs. The other winner for the alumni was Joe Pressing '84 who captured the 55-meter hurdles (7.88 seconds).

Perhaps the most exciting race of the day was the 3000-meter run in which Sumner Brown '66 sealed the team victory for the alumni by placing second (8:50.89) just behind Gordon Holterman '87, (8:50.22).

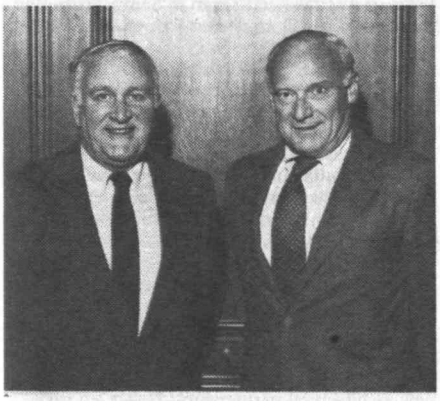
Other varsity winners were Ed Arenberg '85, 55-meter dash (6.72), Dave Richards '86, 400-meter dash (50.88), and the 800-meter relay team of Richards, Dan Lin '86, Mike Hammond '87, and Arenberg (1:34.43).

Greg Hunter '76 placed second in the shot put, tied for third in the high jump, and competed in the 55 hurdles. Hunter, by the way, is in his first year as head coach of track and field at MacAlester College in St. Paul, Minn.

A banquet was organized by M.I.T. Coach Gordon Kelly and his assistant Halston Taylor. On hand were former M.I.T. track coach Art Farnham and Harold Ingraham '49, who still holds the varsity record in the quarter-mile (48.8 seconds). *Ken Cerino* □



PHOTOS: KEN CERINO; BRIAN MOORE, '73; MARIO SCATTOLONI



He may not have played anything, as he said, since last summer's softball, but Lew Bender, '81 (facing page) looks more than ready for the pole vault in the 1984 Alumni Varsity track meet. Among the competitors in the 35-lb. weight throw and shot put were (above, left to right): Steve Sifferlen, '78; Patrice Parris, '85; Greg Procopio, '85; and Brian Moore, '73. Moore set a new facility record in the weight throw and won shot put as well. Among guests for the alumni/track banquet were (far and near left): former coach Art Farnham and Harold Ingraham.

Educational Counsellors Honored

Morgan Awards for service to the Educational Council were presented at the Toronto Alumni Conference to (left) Louis Young, '50, and Charles Griffiths, '37—shown in the adjacent picture with Bonny Kellermann, '72, director of the Council. Young was honored for going into urban minority schools in Los Angeles to encourage students to apply to M.I.T. Griffiths, an educational counsellor in Binghamton, N.Y. for more than 30 years, served as a two-way channel of detailed information between prospective students and the Institute, and did it in an enthusiastic way which students commented on years later.

I CIVIL ENGINEERING

A surprise announcement early this year from Professor **Joseph M. Sussman,** Ph.D.'67: he will retire as head of the department at M.I.T. at the end of the current academic year. Sussman says he wants to devote more time to teaching and research in his chosen field of rail transportation. Dean **Gerald L. Wilson,** '61, of the School of Engineering has appointed a search committee for Sussman's successor; Sussman, he says, has brought "energy and vision that will be a challenge to his successor. . . . He has broadened my understanding of the engineering profession and its wider role in society."

Three alumni in the department were among five winners of the American Society of Civil Engineers' 1984 Huber Prize: Professor **Erik H. Vanmarcke,** Professor **Ross B. Corotis,** '67, chairman of the department at Johns Hopkins University, and **Patrick J. Ryan,** Ph.D.'73, chief hydrologic engineer at Bechtel Civil and Minerals, Inc. Vanmarcke was cited for his research on the application of probablistic techniques in geotechnical, structural and seismic problems in civil engineering; Professor Corotis, whose graduate degrees are also from M.I.T., for research on stochastic modeling of structural loads and the statistical analysis of load data; and Ryan for research on hydrothermal behavior of cooling ponds, lakes, and reservoirs.

Associate Professor **Yosef Sheffi,** Ph.D.'77, in the department at M.I.T. is the author of *Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods* (Prentice Hall, 1984). This textbook describes an analytical approach to determine traffic flow patterns in urban areas—leading to better designs of urban transportation facilities. . . . **George Kenyon Withers, Jr.,** S.M.'62, has been appointed Deputy Assistant Secretary for Military Application and Director of the Office of Military Application for Defense Programs at the U.S. Department of Energy (DOE). Withers' responsibilities include the management of the DOE program for research, development, testing, and production of nuclear warheads and retirement of weapons upon their return from the Defense Department.

Robert S. Broughton, S.M.'59, writes, "As a professor of agricultural engineering at McGill University (Montreal), I work with students and graduates on many challenging projects dealing with water control for crop production—including land reclamation projects in Canada, Pakistan, and Egypt." . . . **Charles C. Noble,** S.M.'48, affiliated with C.T. Main Corp., Boston, since 1974, has been named as the firm's chief executive officer. He has been president and chief operating officer (since 1981) and previously was vice-president of Charles T. Main, Inc., the corporation's engineering subsidiary.

Staunton L. Brown, S.M.'38, who retired as colonel in the U.S. Army in 1958, passed away in Madison, Conn., on October 8, 1984; he was a member of the class of 1934 at the U.S. Military Academy, West Point.

II MECHANICAL ENGINEERING

The National Science Foundation's expenditure on engineering is "totally inadequate," says **Nam P. Suh,** '59, as he completed the first three months of a leave of absence from M.I.T. to be NSF's assistant director for engineering. He wants NSF's engineering support, now $140 million a year, to reach $500 million by the end of the decade, and even that would be "peanuts," he told *Science* reporter Colin Norman, compared with the need. Furthermore, Professor Suh is quoted in *Chemical and Engineering News* as advocating a complete overhaul of NSF's engineering directorate that would eliminate the traditional engineering disciplines as a basis for organization. Instead Suh wants an organization responsive to special needs—basic research, manufacturing systems, national defense, intelligent computers, and others. This kind of talk, combined with Suh's enthusiasm for the new NSF program to provide major funds for interdisciplinary engineering research centers of excellence on university campuses, is said to have alarmed NSF's scientist constituency. Suh responded by dismissing their fears. "The rumor mill is churning out lots of wrong information," he told Norman. "It's what you expect when you do things differently."

A new variable-setting power turbine nozzle assembly, valued at between $50,000 and $60,000, has come to the department at M.I.T. as a gift of Caterpillar Tractor Co. It will be used first in graduate thesis research by **Theo Korakianitis,** S.M.'82, in the field of ocean engineering.

Michael Z. Zimmerman, S.M.'81, is a senior mechanical engineer at the Northrop Corp., Norwood, Mass. . . . **Millard F. Dowell,** S.M.'40, reports, "I am active with the local American Society of Mechanical Engineers and the Erie Engineering Society Council." . . . **James P. Johnston,** professor of mechanical engineering at Stanford University, Calif., has been named an ASME fellow.

Joseph Harrington, Jr., Sc.D.'30, a consultant at Arthur D. Little, Inc., Cambridge, was the recipient of *American Machinist*'s 20th annual AM Award. Harrington was recognized for "perceiving computer integration as the key to the factory of the future . . . contributing to the understanding of the essential nature of manufacturing." Harrington is also in the news as author of *Understanding the Manufacturing Process: Key to Successful CAD/CAM Implications* (Marcel Dekker, Inc., 1984) dealing with "the simple cycle that underlines all manufacturing." Harrington emphasizes that "the structure of the science of manufacturing is the same whether one is making airplanes, computers, canned soup, paper clips, lead pencils. . . . The same basic functions are performed"—but today's manufacturers are making the process harder than it has to be.

Andrew Johnson, Sc.D.'43, a former assistant professor of chemistry at M.I.T. and a member of the Educational Council, passed away in New Castle, Penn., on October 13, 1984. Prior to his retirement, Johnson was technical director of a glass container industry research corporation and director of the W. Keith McAfee Laboratory at the Universal Rundle Corp., New Castle. . . . **John A. Lowry,** '35, of Columbus, Ohio, passed away on July 1, 1984; no details are available.

III MATERIALS SCIENCE AND ENGINEERING

Gilbert Chin, Sc.D.'59, has been appointed director of the Materials Research Laboratory at AT&T Bell Laboratories, Short Hills, N.J. He is responsible for overseeing research on metals, alloys, glasses, ceramics, and semiconductors. At Bell Labs since leaving M.I.T., Chin has been honored widely for his work on the magnetic and mechanical behavior of metals and alloys. . . . **Daniel Gans, Jr.,** '52, is a consulting nuclear engineer for Stone and Webster Engineering Corp. . . . **Charles W. Finn,** Ph.D.'71, reports, "After seven years in Australia and seven in South Africa, I've returned to M.I.T. to do research on aluminum extraction."

Edward Terner, S.M.'65, of Shelburne, Mass., a scientist for the past 16 years with IBM, passed away in Boston on September 27, 1984. Earlier he had served in the Royal British Navy, and he was a member of the U.S. power squandron. . . . **Michael Humenik, Jr.,** Sc.D.'52, director of manufacturing research staff at Ford Motor Co., Detroit, Mich., passed away on July 15, 1984; no details are available.

IV ARCHITECTURE

Jeffrey Heller, M.Arch.'64, has left his position as a partner of Kaplan/McLaughlin/Diaz, to form a new architectural partnership—Heller & Leake, Architects, San Francisco. The firm was formed "in order to exercise more complete personal control and attention to our projects," says Heller. . . . **Chu-Tzu Hsu,** M.Arch.'76, reports that in January 1984 he started his own architectural/planning firm—C.T. Hsu & Associates, Orlando, Fla. . . . **Kenneth L. Kantor,** S.M.'79, has been appointed to the new position of director of advanced development and research for Teledyne Acoustic Research, Norwood, Mass., responsible for research and development activities.

V CHEMISTRY

Mark S. Wrighton, Frederick G. Keyes Professor of Chemistry at M.I.T., has received the 1984 Fresenius Award of Phi Lambda Upsilon, the honorary chemical society. Wrighton was selected for his commitment to undergraduate teaching and advising. . . . **Gilbert Moos,** Ph.D.'39, writes, "Wow! I am now a professor emeritus. The years certainly passed quickly. The new directory made me think about many people I would like to see and talk to again." . . . **Allen Gee,** Ph.D.'51, reports that both he and his wife are now retired. . . . **Frederick K. Watson,** Ph.D.'36, also retired,

reports that he lives in Marathon, Fla., during the winter and Spofford, N.H. during the summer.

Ernest R. Gilmont, Ph.D.'56, former director of technology for M&T Chemicals, Inc., has joined the Chemical Industries Section of Arthur D. Little, Inc., based in New York City. In Gilmont's new role, as a senior consultant, he provides general management counsel to firms in the chemical and related process industries. . . . **John T. Marvel,** Ph.D.'64, general manager of the Research Division at Monsanto Agricultural Products Co., St. Louis, Mo., has been named a co-winner (with his partner) of Monsanto's $25,000 Thomas/Hochwalt Award for outstanding scientific and technical contributions in 1984. The team was cited for their work in improving the understanding of the environmental fate of pesticides in soil, water, animals, and plants.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Interviewed by Alan Daly for *Mass High Tech,* **Thomas Willemain,** Ph.D.'72, senior vice-president (and co-founder) of Smart Software, Inc., Belmont, Mass., says personal computers have revolutionized the art and practice of business forecasting. Analysts can now "see pictures of their data . . . a tremendous impact on the state of the forecasting art." Willemain's interview was timed to his company's sale of its 100th "Smart Forecasts" software package, an "off-the-shelf" integrated financial forecasting system that "allows the novice statistical analyst to generate accurate forecasts with as little as two hours' training." Smart Software, founded in 1981, operated as a management consultancy for three years, now has changed its focus to microcomputer software development.

An experimental visiting-faculty program in the department at M.I.T., which began last fall under a $250,000, five-year grant from GenRad, Inc., is bearing fruit. GenRad's idea is to fund visiting faculty from other institutions for temporary teaching at M.I.T.—thus helping the M.I.T. department respond to the continuing pressure of high undergraduate enrollments. The first two visitors are **Jose Manuel Moura,** professor of electrical engineering at the Instituto Superior Technico, Lisbon; and **Paris C. Kanellakis,** Ph.D.'82, assistant professor of computer science at Brown.

Mildred S. Dresselhaus, Abby Rockefeller Mauze Professor in the department, has been chosen a new director of the American Association for the Advancement of Science, taking office on June 1 during the association's annual meeting in Los Angeles. At the same time, Professor **Peter Elias,** '44, will become chairman of the AAAS' Section M—Engineering.

James S. Miller, '76, now holds a fellowship to complete his doctoral program at M.I.T. from the Faculty Development Program of the American Electronics Association supported by the Wang Corp. The AEA program provides a combination of stipend and loans—the latter being cancelled if the recipient teaches full-time for three years following completion of the doctorate. Miller's work is in artificial intelligence. Prior to returning to M.I.T. two years ago, he was associated with Bolt, Beranek and Newman, Cambridge, and studied for a master's degree in engineering management at the University of Alaska, Fairbanks.

M.I.T.'s Laboratory for Electromagnetic and Electronic Systems (LEES) has a new director: Professor **James R. Melcher,** Ph.D.'62, Stratton Professor of Electrical Engineering and Physics. He succeeds Professor **Thomas H. Lee,** who is on leave to be director of the International Institute for Applied Systems Analysis (IIASA) near Vienna. LEES work, done by 13 faculty and 10 research staff in electrical and mechanical engineering, includes power electronics, automatic control, insulation research, cell biophysics, electromechanics, and heat and mass transfer.

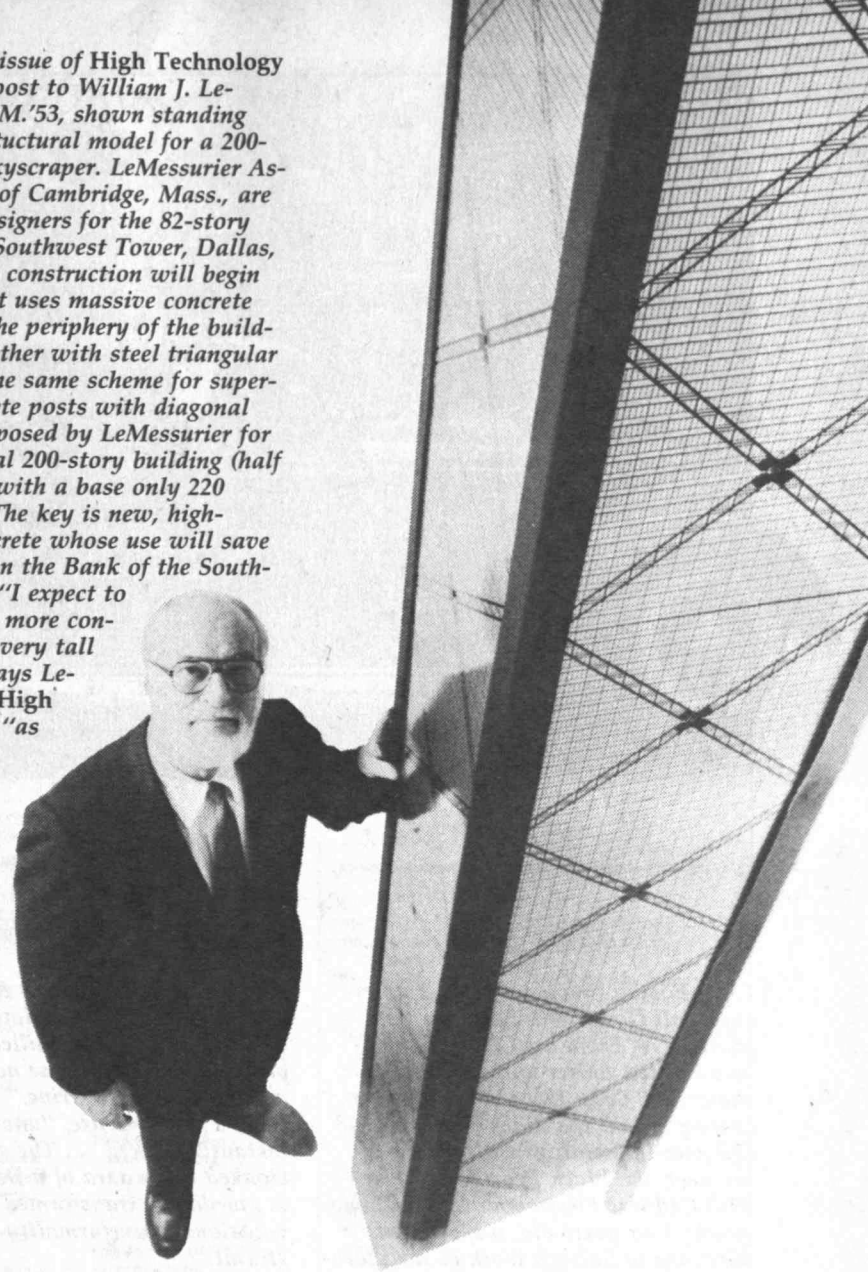
Don't underestimate the task of making a fifth-generation "smart" computer, says Professor **Michael Dertouzos,** Ph.D.'64, director of the M.I.T. Laboratory for Computer Science. That will be a big, long-term job, Dertouzos told the Association of Computing Machinery last fall, and "we've got to get off the 'moon-shot' mentality, the attitude that we're going to achieve *this* by *then*. . . . Let's get off the short-term kick and take a long-term orientation,' " Dertouzos urged.

Two alumni of the department have been announced as winners of American Physical Society awards: **J. Ross MacDonald,** '44, professor of physics at the University of North Carolina, received the George E. Pake Prize at APS' March meeting in Baltimore, Md., and **Jack J. Schuss,** '73, of the Bitter National Magnet Laboratory staff, has shared the 1984 Award for Excellence in Plasma Physics Research, presented at the APS Division of Plasma Physics in Boston late last fall. MacDonald is cited for "innovation and creativity . . ., broad theoretical and experimental research interests . . ., and superior leadership capacity."

Henry J. Dumas, S.M.'58, former vice-president of sales at Scanning, Inc., Watertown, Mass., has joined Eastern Air Devices, Dover N.H., as sales manager. Dumas will be responsible for directing all sales representative organizations. . . . **Robert B. Wilcox,** S.M.'48, was among those receiving the Institute of Electrical and Electronics Engineers' Centennial Medal for his "outstanding contributions to the profession of control systems." The award was presented last December at the IEEE's Control Systems Society annual convention. Wilcox had been employed for the past 22 years, until his retirement (last November), as an engineering manager at the Mitre Corp., Bedford, Mass.

Ko Muroga, S.M.'54, writes that his firm, "NEC America (Melville, N.Y.), acquired 210 acres of land near Portland, Ore., for fiber optics production." . . . **Maurice Herlihy,** S.M.'80, is a faculty member in the Computer Science Department at Carnegie-Mellon University, Pittsburgh, Penn. . . . **Edward J. Craig,** Sc.D.'54, was appointed dean of engineering at Union College, Schnectady, N.Y., last year. . . . **Ronald E. Scott,** Sc.D.'50, professor of electrical engineering at Northeastern University, Boston, is chairman of the Boston Section of the IEEE for the 1984-85.

Kurt J. Linden, S.M.'61, has joined Spire Corp., Bedford, Mass., as manager of the Electronics Materials Dept. with the chief responsibility of increasing the capacity of Spire's epitaxial gallium arsenide wafer service business. Prior to joining Spire, Linden was director of laser research and development at the Laser Analytics Division of



The January issue of* High Technology *gave a big boost to William J. LeMessurier, S.M.'53, shown standing next to his stuctural model for a 200-story superskyscraper. LeMessurier Associates/SCI of Cambridge, Mass., are structural designers for the 82-story Bank of the Southwest Tower, Dallas, on which the construction will begin this spring. It uses massive concrete columns at the periphery of the building, tied together with steel triangular diagonals. The same scheme for superstrong concrete posts with diagonal braces is proposed by LeMessurier for a hypothetical 200-story building (half a mile high) with a base only 220 feet square. The key is new, high-strength concrete whose use will save $25 million on the Bank of the Southwest Tower. "I expect to see more and more concrete used in very tall buildings," says Lemessurier in* High Technology, *"as people wake up to the enormous economy of it."

PHOTO: MARTIN PAUL

For a Boston limousine with a difference, call Douglas C. Sulzer, M.Arch.'76. From his Classic Limousine Service, Sulzer will give you a choice: the Gray Lady, a 1948 Dodge custom sedan; the Black Swan, a 1948 Chrysler Imperial; or the flagship of the fleet, the Black Pearl (above), a 1935 Cadillac Fleetwood. Classic Limo is now four years old, a successful auxiliary to Sulzer's work as a restoration architect in Boston. Among available accessories: fresh flowers, classical music, and chilled champagne. "Whenever these nostalgic cars are summoned to arrive," says Classic Limo's press release, "another era is instantly evoked . . . The customer is cloaked in an aura of a Bogart movie . . . weddings transformed into elegant occasions when formality dictated restraint."

Spectra Physics. . . **Myles A. Larson,** S.M.'69, has been promoted from manager to director of weapon control systems at E-Systems ECI Division, St. Petersburg, Fla. Larson has been with ECI since 1974, serving in several technical positions. . . . **Richard M. Harris,** S.M.'63, has been promoted from associate technical director to technical director of the Naval Systems Engineering Division at the Mitre Corp., Bedford, Mass. He's responsible for C^3I systems engineering for Mitre's navy, marine, and defense projects.

VI-A INTERNSHIP PROGRAM

The new heading, above, announces a change in the title of what since 1981 has been called the "VI-A Program" and for the previous 63 years was labeled "Course VI-A." Adding the word "internship" to our title is designed to give the program a more accurate and descriptive name—how VI-A actually functions. The previously applied phrase "co-op" or "co-operative" confuses VI-A with less rigorous types of "earn-while-you-learn" programs. The updating of our title also brings it in line with that of the Engineering Internship Program, the title chosen in 1978 for the School of Engineering's program, based on the success of VI-A, for consolidating existing individual programs in disciplines other than Course VI-A. The idea of a title change has been discussed by several previous VI-A administrations and has finally become a fait accompli—effective immediately.

This title change should help the department in its relations with our VI-A co-operating companies by better defining what we expect from the program and the greater attention we expect company management to pay to the specialized assignments VI-A requires for the completion of the master's thesis requirements.

Another immediate beneficiary of the title change will be our VI-A foreign students who, under the old "co-op" definition, had their VI-A work time deducted from the one year they were allowed to obtain experience in U.S. industry following graduation. By federal definition, this rule does not apply to "internship" students; so, now, our VI-A students will receive the same treatment as students in the Engineering School's E.I.P.

When this article appears in print, VI-A will be well into its annual process of selecting a new entering class. The department will be applying restrictions, this year, on the number of students our companies can hire. This will be done in order to bring down the total enrollment to nearer our projected goal of 250 students—a size the department has felt for some time is the maximum its present faculty and staff can handle. We will expect to add about 85-90 new students during this spring's recruiting. Current enrollment is about 299.

Joining the VI-A Internship Program this year will be Bellcore (Bell Communications Research) formed as a result of the recent AT&T divestiture. One of our VI-A graduates, **Chester M. Day, Jr.,** '57, is co-ordinating Bellcore's introduction to the program. Its counterpart AT&T Bell Laboratories will continue its participation.

RCA's Astro-Electronics Division has decided not to continue its participation in VI-A but will continue its present students until they graduate from the program. RCA's Sarnoff Laboratory will continue its participation, though.

A press release from the New England Electric System companies informs us that **Robert O. Bigelow,** '49, has been named vice-president of New England Electric System as of January 1, 1985. In addition to his continuing responsibilities as director of planning and power supply, Bigelow is president of New England Electric's international transmission services company. The Boston Edison Co. was his VI-A employing company.

A note in my file reminds me that at the fall VLSI research review, held at M.I.T. on December 17, 1984, Director Tucker met **Fred L. Terry, Jr.,** '80, who is finishing his Ph.D. at M.I.T., and **Ronald R. Troutman,** '62, from IBM Corp., Essex Junction, Vt.

A call from **Shahram Shirazi,** '77, tells us that he is now with ZILOG Corp., Campbell, Calif. . . . **Vincent H. Tobkin,** '73, was in the Boston area in mid-January and came by the VI-A Office. He and Mr. Tucker had a lengthy visit discussing West Coast VI-A alumni. Vincent has joined as a partner Sierra Ventures, Menlo Park, Calif.

Other visitors have included: **George B. Yundt,** '80, with IMEC Corp., Boston, and **John G. Strang,** '83, who's in medical school at Northwestern University in Chicago.

Completing our list, started in our previous article, of VI-A's sending us seasons greetings, we also heard from: **William R. Bidermann,** '76; **Mark T. Fuccio,** '80; **L. James Marggraff,** '80; **Kenneth A. Parulski,** '79; **Paul E. Stoft,** '49; and **Vincent H. Tobkin,** '73. We appreciate all these remembrances.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 02139

VII BIOLOGY

Professor **Jonathan King** of M.I.T. has been named to the committee on nominations of the American Association for the Advancement of Science; he'll help choose nominees for major AAAS offices to be elected for 1985-86.

Elizabeth Wilson, M.P.H.'40, retired in 1983 as executive director of the Connecticut Association for Home Care in Wallingford. She is now president of Pomeraug Woods, a proposed life-care center, Southbury, Conn. . . . **Edward W. Baptist,** Ph.D.'73, has joined the faculty of the East Carolina University Department of Biology, Greenville, as lecturer, devoting part of his time to developing the biotechnology curriculum. He previously served as senior research scientist with Southern Biotech, Greenville.

Moshe Siev, S.M.'69, last summer joined the Pediatric staff at Bridgeport (Conn.) Hospital. Siev is also a member of the staff of Connecticut Health Plan in Bridgeport.

Kathleen M. O'Grady, S.M.'77, a physician and specialist in internal medicine, is the newly appointed medical director of Memorial Urgent Care, West Boylston, Mass. This facility is the area's first hospital-affiliated (Worcester Memorial Hospital) medical treatment center for minor emergencies.

PHOTO: FRANK REVI '86

VIII PHYSICS

Albert G. Hill, now professor emeritus, began teaching physics at M.I.T. in 1937; he rose to become a major figure in the Research Laboratory of Electronics after World War II and later in the M.I.T. administration, where he was the chief architect of the divestment of the M.I.T. Instrumentation Laboratory into today's independent Charles Stark Draper Laboratory, Inc. Late last fall, Hill was honored by Draper Laboratory when his name was given to a new Cambridge building that nearly doubles the laboratory's space. Howard W. Johnson, former president of M.I.T. under whom Hill served as vice-president for research, called Hill "a great physicist, great engineer, great teacher, and great patriot," and Draper's president, Robert Duffy, credited him as architect of "a transition that kept M.I.T. and the laboratory friends . . . a key element in the strength of the laboratory today." Duffy characterizes Draper as "the primary inertial systems design agent in the country" and says its future emphasis will be on "much more complex, highly integrated, complete systems . . . performing functions previously the responsibility of human operators." Furthermore, said Duffy, President Reagan's strategic defense initiatives "fall right in line with the experimental work we have been doing."

Michael Guerra, Ph.D.'76, is head of the Research and Development Group of Nova Ion Implantation Systems, Everett, Mass.

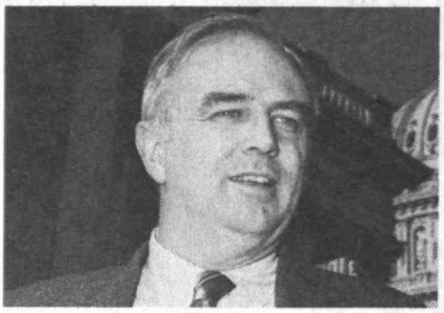
X CHEMICAL ENGINEERING

Albert S. Humphrey, S.M.'49, reports from London that his firm, Business Planning and Development, had "an all-time high sales record" for 1984, which he attributes to his own and others' use of his business development technique called Team Action Management (TAM). It's described as "a systematic, structured technique for sitting managers round a table to diagnose problems, prescribe remedies, and provide budgeted plans to carry out the treatment . . . a mechanical process aimed at breaking down the psychological barriers to team work."

A unique tribute on his 60th birthday to **Edward W. Merrill,** Sc.D.'47, Carbon P. Dubbs Professor at M.I.T.: the October 1984 issue of *Chemical Engineering Communications* published in his honor. The guest editors—Professors **David J. Graves,** Sc.D.'65, of the University of Pennsylvania and **Nikolaos A. Peppas,** Sc.D.'74, of Purdue—describe their former mentor as "truly a Renaissance man . . . with broad interests and the ability to inject ideas from one discipline into another. . . . He is one of the main forces behind the eventual acceptance of biomedical research as a legitimate and viable area within our profession." The issue includes a number of scholarly articles by Merrill's former graduate students, research associates, and other collaborators.

Robert L. Rorschach, S.M.'43, president of Process Technology Corp., Tulsa, Okla., has been named a fellow in the American Institute of Chemical Engineers (AIChE). Rorschach specializes in computer-aided process design of heat transfer equipment. He is a past chairman of AIChE's Tulsa section; helped to establish the group's Andre Wilkins Award; and serves on the editorial review board for the AIChE's quarterly *Energy Progress*. . . . **Norman A. Robins,** S.M.'55, formerly vice-president—research, is vice-president for technical assessment at Inland Steel Co., Chicago. . . . **Chau-Chyun Chen,** Sc.D.'80, principal engineer with Aspen Technology, Inc., Cambridge, has been awarded the Ted Peterson Student Paper Award by the AIChE's Computing and Systems Technology Division. His paper, "A Local Composition Model for Excess Gibbs Energy of Electrolyte Systems," was published in the *AIChE Journal* in 1982.

John G. Polk, S.M.'53, has been elected execu-



L. Aspin

Alumnus Aspin Takes Top Congressional Post

Representative Les Aspin, Ph.D.'66, has a big new job: at age 45, he is the youngest member of the House of Representatives ever chosen to chair the House Armed Services Committee.

Aspin, a Democrat from Wisconsin, is far more liberal than most of his recent predecessors in that influential job. Fred Kaplan of the *Boston Globe* says Aspin has the job because he promised House Democrats to contain expenditures for the MX missile and because of his reputation as a critic of military extravagance. The committee "will certainly subject the Pentagon to greater scrutiny than before," says Kaplan.

Aspin ran what Kaplan calls "a daring and successful political campaign" for the Armed Services Committee chairmanship, seeking for the first time in 20 years to unseat an incumbent chairman (Representative Melvin Price of Illinois). It worked; a majority of Price's committee colleagues voted him out of the job. Explains Masschusetts' Representative Barney Frank: "People realize that a major difference between us and the Republicans is over the military budget. . . . We wanted a strong man out front in this fight."

Aspin, whose M.I.T. degree is in economics, first went to Congress in 1970 after several years as a systems analyst in the Pentagon. He quickly "fashioned a reputation as an outspoken critic of military waste," writes Kaplan.

Aspin is remembered by his M.I.T. thesis supervisor, Professor Emeritus Douglass V. Brown, as having "a flair for getting information from people"—a good interviewer. Aspin himself confirms the value of that ability in his advice to students interested in policy careers. In such assignments, he said, you must "appreciate the ramifications of different policy options and balance the interests and opinions of the people who will be affected by the policy." □

tive vice-president and sector executive, packaging of American Can Co., Greenwich, Conn. Prior to this appointment, Polk had been senior vice-president for operations control. . . . **W. Kenneth Davis,** S.M.'40, deputy secretary of the Department of Energy from 1981-83 who is now a consultant to Bechtel Power Corp., San Francisco, has been elected a vice-chairman of the International Executive Council of the World Energy Conference (for a three-year term). Prior to Davis' involvement with the DOE, he served for over 20 years as corporate vice-president of Bechtel Power Corp. and its predecessor companies.

Peter V. Danckwerts, S.M.'48, Shell Professor of Chemical Engineering at the University of Cambridge, England, from 1959 to 1977 and Fellow of Pembroke College, passed away on October 25, 1984. While at Cambridge, Danckwerts established an international reputation in the early 1950s with the publication of several of papers notable for their fruitful application of mathematics to the basic mechanisms governing the operation of chemical plants. There followed many years of research activity in a variety of topics such as: gas absorption, mixing, and residence time distributions. It was with industrial innovation in mind that Danckwerts left Cambridge in 1954 to work under Lord Hinton at the Atomic Energy Authority. Shortly after, he returned to academic life at Imperial College and then back to Cambridge, where he established a research school which included continuing his earlier work on surface renewal at gas-liquid interfaces.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

Roger G. Burns, professor of mineralogy and geochemistry at M.I.T., has received an honorary doctor of science from his alma mater, Oxford University, England, where he taught before joining the M.I.T. faculty in 1970. The degree recognizes Burns' contributions to metal geochemistry and mineral spectroscopy, providing new data for understanding geophysical and geochemical properties of the earth's interior and the surfaces of terrestrial planets.

E. Bruce Watson, Ph.D.'76, has been promoted to professor in the Department of Geology at Rensselaer Polytechnic Institute, Troy, N.Y. Since joining RPI in 1977, Watson has been conducting research on the earth's evolution, and last spring received a Presidential Young Investigator Award.

Stanley H. Southwick, Ph.D.'51, passed away suddenly in Friend, Neb., on April 20, 1984. "Although he had given up his career as a scientist in order to take over control of the family bank here in Friend, he kept up on scientific developments . . . He was a unique man with many admirable qualities," wrote his son, Les F., in a letter to the Alumni Association. . . . **Clarence J. Grogan,** '42, of Madison, Va., passed away on March 24, 1984; no details are available.

XIII OCEAN ENGINEERING

Harry E. Davis, S.M.'42, reports that he has retired from active employment and resides in Lake Placid, N.Y. . . . In memory of **James A. Lisnyk,** S.M.'64, who was killed in an automobile accident on August 1, 1984 (*see January 1985, p. A21*), the Flagship Section of the American Society of Naval Engineers (ASNE) has sponsored the establishment of the Dr. James A. Lisnyk Memorial Scholarship, to be funded by donations and be part of the ASNE Scholarship Program. . . . **Roderick M. White,** Sc.D.'65, is executive director of the Coast Guard Academy Foundation.

XIV ECONOMICS

A. Lawrence Kolbe, Ph.D.'79, is the co-author—with James A. Read, Jr., S.M.'80 (XV)—of *The Cost of Capital: Estimating the Rate of Return for Public Utilities* (M.I.T. Press, 1984). The book is described as "a thorough review and critique . . . of the major methods used to estimate the rate of return allowed investors under public utility regulation." Both authors are affiliated with Charles River Associates, Boston, Kolbe as vice-president and Read as senior research associate.

Heather L. Ross, Ph.D.'70, began a two-year overseas assignment in London with British Petroleum at the end of last year. . . . **Richard L. Gordon,** Ph.D.'60, writes, "Served on the much publicized Commission on Fair Market Value Policy for the Federal Coal Leasing (August 1983 to March 1984)."

Robert N.C. Hessel, '27, a former department superintendent at Worcester (Mass.) Works, U.S. Steel Corp., passed away on July 20, 1984, at the age of 80. He had been at the Worcester Works for 43 years, until his retirement in 1969.

XV MANAGEMENT

Professor **Phyllis A. Wallace** of the Sloan School is a member of the advisory committee for a major new study of the status of blacks in the U.S.—a $1.7-million project of the National Research Council. To her role Professor Wallace will bring the view of a concerned skeptic: despite the great public visibility of civil rights and discrimination issues since passage of the Civil Rights Act of 1964, "great economic disparities" continue to separate blacks and whites in the U.S., she writes in a report prepared last year for a conference sponsored by the Joint Center for Political Studies. "Whether some approximation of racial economic equality (can be achieved in) this society," she said, "depends on the long, hard struggle that should engage all of us."

Robert A. Jarrow, Ph.D.'79, received tenure at Cornell's Graduate School of Management, Ithaca, N.Y., in July 1983. . . . **Larry P. Yermack,** S.M.'62, has been appointed director of the Space Station Programs at RCA Astro-Electronics, Cherry Hill, N.J. Yermack joined RCA in 1962 and most recently was director of satellite programs. . . . **Marie E. Regas,** S.M.'83, is working in Detroit, Mich., for Electronic Data Systems on the General Motors account. . . . **Nicholas S. Fiekowsky,** S.M.'78, has joined former Sloan professor Michael Zisman at Soft-Switch, Inc., King of Prussia, Penn., as product manager.

Rogerio Machado, S.M.'77, is director for corporate development at Empresas Machline (computers, banking, and electronic consumer products), Sao Paulo, Brazil. He is responsible for strategic planning, information systems, and management structure.

James B. Law, S.M.'52, chairman of Union Carbide Eastern, Inc., Danbury, Conn., passed away on October 29, 1984. Law joined Union Carbide in 1956 as a process development engineer for the Carbon Products Division in Fosteria, Ohio, subsequently holding management roles for various operations of the corporation in Brazil, Japan, India, and Hong Kong. In 1977 Law was named senior vice-president of Union Carbide Eastern, with responsibility for operations in India, Korea, and China, becoming chairman in 1978. . . . **Stephen T. Colman,** '62, of Chicago, Ill., passed away while traveling in Singapore on October 25, 1984; no details are available.

SLOAN FELLOWS

Robert C. Ernest, S.M.'59, former president of Kimberly-Clark Corp., Neenah, Wisc., became vice-chairman last January 1. . . . **Donald W. Male,** S.M.'58, has been appointed secretary of the Unitarian Universalist Association, Tullahoma, Tenn. . . . **Peter E. Viemeister,** S.M.'69, retired vice-president of Grumman Corp. and former president and organizer of Grumman Data Systems Corp., has been elected to the Board of Trustees at Lynchburg (Va.) College. Viemeister, formerly associate professor of organizational be-

havior at Dowling College is also a member of the Advisory Committee of the Lynchburg College School of Business.

Carl H. Janzen, S.M.'74, has been named executive vice-president of marketing and field operations for Cambex Corp., Waltham, Mass.; responsible for all marketing, sales and field service functions. Prior to joining Cambex, Janzen spent more than 25 years in major managerial assignments in the computer industry. . . . **Wendell Larson,** S.M.'68, senior vice-president in corporate affairs for IC Industries, Chicago, has been re-elected regent for a six-year term of Luther College, Decorah, Iowa. . . . **J. Phillip Samper,** S.M.'73, executive vice-president of the Eastman Kodak Co., Rochester, N.Y., recently announced the company's plans to manufacture and market a new line of diskettes for use with small computers. . . . **Donald S. Gull,** chairman and chief executive officer of Wells International, New York City, has been called by the Church of Latter-day Saints to be the bishop of the New Canaan (Conn.) I Ward.

SENIOR EXECUTIVES

Joan B. Berkowitz, '79, vice-president in charge of the Hazardous Waste Management Section at Arthur D. Little, Inc., Cambridge, was a major speaker last January at the Cambridge Forum. Her subject: "The Politics of Hazardous Waste." She holds the National Achievement Award of the Society of Women Engineers for her 30 years of leadership in the field of waste management.

MANAGEMENT OF TECHNOLOGY PROGRAM

It was good to get a cheerful note at Christmas from **Victor M. Aguado,** S.M.'82. He wrote from Spain that his wife, Paloma, was enjoying her job in the Department of Culture as a documentalist. Victor worked until last June as program manager on the modernization of air traffic control for the Spanish Civil Aviation Administration. He went on to explain that in June he was appointed as executive advisor to the undersecretary of defense. "Next: we do not know yet," he wrote. Congratulations, Victor, on your new assignment!

It looks like **Koichi Kodama,** S.M.'84, has beaten **Ted Finch,** S.M.'84, up the aisle! At the time of this writing, Koichi plans to marry on March 3, in Japan. His wife-to-be is named Miyuki, and he met her last fall through a business trip for Mitsubishi to a small computer company in California. (Miyuki is the daughter of one of the board members of the small company.) When Koichi called Jane Morse in December with the news, he had just returned from a three-week trip to Japan to meet the family and start making wedding arrangements. The Kodamas will live in New York for probably another year, then hope to move back to Japan. Koichi's position at Mitsubishi International (New York City) as manager—high technology, for their Project Coordination Center of America, keeps him very busy and traveling about 50 percent of the time, he says.

Jane Morse had a nice phone conversation with **James C. Tagliaferro,** S.M.'83, in January. Jim has left Centronics, and started at Digital Equipment Co., Woburn, Mass., in October. Jim was hired to head up a new group called Failure Analysis and Corrective Tactics. When he began, he said, the group consisted of "me and five requisitions." He has since succeeded in filling almost all of his openings. He explained that he wears two hats: in one role he works on eliminating problems in new products before they are out the door; in another, his group also examines failure trends in old products. So far, he is enjoying DEC thoroughly. Sounds as though he fits well with the corporate culture, and hopes to stay there for a while. His wife Joyce, is also doing well and reports the family is fine.—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

Professors **Marten Landahl** and **Erik L. Mollo-Christensen,** '48 (Department of Earth, Atmospheric, and Planetary Sciences), are co-authors of *Turbulence and Random Processes in Fluid Mechanics,* to be published in September by Cambridge University Press. . . . **Kumar N.R. Ramohalli,** Ph.D.'71, was awarded the NASA Exceptional Service Medal last December. The citation reads: . . . "for his exceptional contributions to combustion research through the development of accurate models of the detailed thermochemical processes that take place in the combustion of composite materials, including propellants, and for studies of the acoustics of turbulent combustion." Ramohalali is currently with the Department of Aerospace and Mechanical Engineering at the University of Arizona, while holding a part-time academic appointment with the Jet Propulsion Laboratory, Pasadena, where the NASA award presentation was made.

Charles Huebner, S.M.'60, has joined Transway International Corp. as vice-president of strategic planning and analysis at U.S. Industries, Stamford, Conn. Heuber was formerly vice-president of business development at Geosource, Inc., Houston, Tex. . . . **Roger W. Johnson,** S.M.'58, has been elected chairman of the board at Western Digital Corp., Irvine, Calif., where he is president and chief executive officer.

Delmar S. Fahrney, S.M.'30, a retired rear admiral in the U.S. Navy, passed away in La Mesa, Calif., on September 12, 1984. Fahrney retired as leader of the Navy Bureau of Aeronautics' development of target drones and guided missiles in 1950. He then joined the Franklin Institute as secretary to the Science and Arts Committee, retiring in 1973. . . . **George M. Walker,** S.M.'55, a major in the U.S. Air Force, passed away in Wetumpka, Ala.; no details are available.

XVII POLITICAL SCIENCE

Professor **Michael Lipsky** of M.I.T., whose fields are social movements and U.S. food policy, has been named by the National Research Council to the advisory committee for a major NRC study on the status of blacks in the U.S. The goal of the $1.7-million project is "to marshall, assess, and synthesize evidence from many different sources on the change in the status of black Americans during the 40 years since World War II."

Professor **George W. Rathjens** of M.I.T. was among 30 international religious and academic leaders meeting late in 1984 to consider issues raised by the proliferation of nuclear weapons. It was the third in a series of such meetings, and President Theodore M. Hesburgh of Notre Dame explained the hope "that this growing consensus of scientists and religious leaders, virtually unprecedented since Galileo, will affect those who make or influence political policy."

XVIII MATHEMATICS

Professor **Gian-Carlo-Rota** of M.I.T. was honored late last year with the Docteur Honoris Causa from the Universite Louis Pasteur, Strasbourg, France, the highest honor given by a French university. Rota, well known for his undergraduate lectures in mathematics, is a student of combinatorics and its applications.

"In the traditional math classes, students seldom talk to each other at all. Here we get students fired up to do more, to care about getting results." . . . **William H. Barker,** Ph.D.'73, is describing the results of his "discovery method" of teaching college calculus at Bowdoin College. Barker's students are divided into groups of four or five to work together, proving theorems, solving problems, and constructing examples. His success has won him a chapter in a new book by Ken

Macrorie, *20 Teachers* (Oxford University Press, 1984), in which Macrorie describes teachers in terms of their students' success. At Bowdoin since 1975, Barker has helped establish Bowdoin's self-paced calculus program and is co-author of a calculus text, The Calculus Companion.

Professor **Harvey M. Friedman,** Ph.D.'67, of Ohio State University received the 1984 Alan T. Waterman Award for "outstanding capability and exceptional promise for future achievement" presented last May at the National Academy of Sciences. Friedman is described as a mathematical logician whose philosophical perspective yields "mathematical subjects and theorems of depth and beauty"; he was one of 132 nominees for the 1984 award, the ninth in the series intended to encourage the work of young scientists. Friedman, who received his M.I.T. degree at the age of 18, has been professor of mathematics at Ohio State since 1977.

Richard M. Soland, Ph.D.'64, writes, "I was conference chairman of IFORSX, the tenth triennial conference of the International Federation of Operational Research Societies, held in Washington, D.C., last August. During the spring of 1985, I will be acting chairman of the Department of Operations Research of the George Washington University." . . . **William E. Ritter,** Ph.D.'62, retired from CVA and Crohn, due to poor health.

XXI HUMANITIES

A new Class of 1922 Professorship, funded from 40th and 50th reunion gifts and by individual class members, has now been assigned to **Cynthia Griffin Wolff,** professor of literature. Wolff is best known for her study of the life and work of American novelist Edith Wharton, and she is currently working on a major study of the life and work of Emily Dickinson due to be published in 1986, the centennial of the poet's death. Wolff joined the M.I.T. faculty in 1980 after studying at Radcliffe and Harvard and teaching at the University of Massachusetts at Amherst.

Meeting with Professor Richard de Neufville, '60 (center), Governor John Sununu, '61, of New Hampshire helped inaugurate the activities of an advisory board to the Technology and Policy Program in the School of Engineering late last fall. With them in the picture: Professor Nicholas A. Ashford (right), director of the Center for Policy Alternatives.

TECHNOLOGY AND POLICY PROGRAM

Four members of our new TPP advisory board met in Cambridge late last fall: **John P. Horton,** '49, former assistant administrator of the Environmental Protection Agency who is now president of Danline Industries, Kenilworth, N.J.; **John Sununu,** '41, governor of New Hampshire; **Bernard Rabinowitz,** '47, president of Atlantic Industries, N.J.; and Robert Weinberg, chairman of the Massachusetts Port Authority. The late **Howard J. Samuels,** '41, had agreed to serve, but died before the time of the group's first meeting. The board members were enthusiastic about what they heard, and they said they would have hired several of our students on the spot if they'd been available.

Professor **Nicholas A. Ashford,** a major participant in TPP who directs the Center for Policy Alternatives, is a member of the nominating committee for Section X of the American Association for the Advancement of Science; he'll help choose officers for this "general" section of AAAS for 1986.

We report with delight a $40,000 grant to M.I.T. from Xerox Corp. to fund graduate fellowships for TPP students. Xerox says the grant is to encourage students to choose careers in technology and policy—especially in communications and related fields in which Xerox is an international leader; clearly, Xerox understands as we do that it is neither responsibile nor good business to ignore the larger social implications of new technologies. We'll use the fellowships to encourage entering graduate students to choose the TPP program.

Dick Kutta, S.M.'80, has been promoted to manager of Project Engineering with Seven-Up. He is working with Seven-Up's plant construction projects throughout North America. . . . **Steve Izatt,** S.M.'84, is now working in the newly created Technology Transfers and Ventures Department at Bethlehem Steel, Allentown, Penn., where he anaylzes new, high-growth, high-potential business areas of a technological nature.

Carol Eberhard, S.M.'82, has recently accepted a position with the International Programs Office at the Nuclear Regulatory Commission, where she is doing assignments of safeguards in individual countries to determine whether the NRC should export nuclear material/technology abroad. . . . **Rick Hornby,** S.M.'79, has been appointed Assistant Deputy Minister of Energy, Department of Mines and Energy, Nova Scotia, and is involved in planning for tidal power, gas sales to the United States, and the development of Georges Bank.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

Jerome H. Holland, 1916-1985

Jerome H. Holland, prominent black educator and civil rights advocate who was a member of the Corporation from 1969 to 1979, died in New York on January 13 of cancer; he was 69.

Dr. Holland studied sociology at Cornell and the University of Pennsylvania and went on to become president of two predominently black colleges, Delaware State College and later Hampton Institute, before accepting appointment as Ambassador to Sweden.

In addition to his service on the M.I.T. Corporation and its visiting committees for the Center for International Studies, Department of Humanities, and athletics and student affairs, Dr. Holland was national chairman of the American Red Cross and the first black on the board of the New York Stock Exchange.

Deceased

Robert S. Beard, '05; 1983; Trinidad, Calif.
Mrs. Milton E. Hayman, '11; 1984; West Hartford, Conn.
Clifford L. Muzzey, Sr., '14; December 15, 1984; Sandusky, Ohio.
Solomon Schneider, '15; October 12, 1984; Havertown, Penn.
James B. Hobbs, '16; January 6, 1985; Natick, Mass.
Donald B. Webster, '16; November 25, 1984; Falmouth, Mass.
Benjamin I. Lewis, '17; December 21, 1984; Tacoma, Wash.
R. Parry Kennard, '18; 1984; New York, N.Y.
John S. Coldwell, '19; September 21, 1984; Fall River, Mass.
Shee M. Lee, '19; 1984; Hsinchu, Taiwan.
Chester C. Stewart, '19; May 18, 1984; Needham, Mass.
George H. Wiswall, Jr., '19; 1982; Edgartown, Mass.
Preston W. Smith, '21; January 6, 1985; North Weymouth, Mass.
Charles Kerr, Jr., '22; Fort Point, Fla.
Dwight E. Stagg, '22; November 13, 1984; Bridgeport, Conn.
William P. Winsor, '23; December 16, 1984; New York, N.Y.
Gordon H. Crabb, '24; August 1, 1984; Winter Park, Fla.
Mrs. Theodore G. Coyle, '25; July 12, 1984; Norwood, Mass.
Marvin H. Green, '25; November 6, 1984; N. Palm Beach, Fla.
Eugene C. Hermann, '25; August 20, 1984; Westfield, N.J.
George Oetinger, Jr., '25; 1984; Monticello, Fla.
Peter H. Sin, '25; September 13, 1984; Hong Kong.
Mrs. George V. Slottman, '25; January 5, 1984; New York, N.Y.
Elmer C. Warren, '26; October 11, 1984; Waterville, Maine.
Adelbert N. Billings, '27; November 13, 1984; Richmond, Va.
Laurence H. Coffin, '27; November 11, 1984; North Conway, N.H.
George D. Fexy, '27; September 1984; Kirkland, Wash.
Randolph J. Peterson, '27; November 4, 1984; Rochester, N.Y.
John M. Ryan, '28; November 3, 1984; Winchester, Mass.
John D. McCaskey, '29; January 10, 1985; St. Joseph, Mo.
Theodore Criley, Jr., '30; January 1985; Claremont, Calif.
Norman H. Dolloff, '30; October 3, 1984.
Harry J. Fekas, '30; November 2, 1984; Newport News, Va.
Emile P. Grenier, '31; December 12, 1984; Ann Arbor, Mich.
John Vasta, '31; 1984; Punta Gorda, Fla.
George E. Colby, '32; October 3, 1984; Westport Harbor, Mass.
John F. Crowther, '32; October 19, 1984; Old Lyme, Conn.
George Henning, '33; November 21, 1984; Syosset, N.Y.
Walter S. Brodie, '34; January 20, 1985; Marblehead, Mass.
Karl A. Gardner, '34; January 3, 1985; Northridge, Calif.
Herbert L. Gamer, '34; November 26, 1984; Milton, Mass.
Proctor Wetherill, '34; January 16, 1985; Chester Springs, Penn.
Stephen H. Richardson, '36; 1984; Seattle, Wash.
Robert M. Sherman, Jr., '36; November 27, 1984; Warwick, R.I.
Staunton L. Brown, '38; October 8, 1984; Madison, Conn.
Roscoe J. Cooper, '38; August 27, 1984; Beverly, Mass.
Edgar H. Kibler, Jr., '39; 1983.
Michael Morelli, '40; November 16, 1984; Alexandria, Va.
George Farnell, '41, September 2, 1984; Syracuse, N.Y.
J. Nelson Evoy, Jr., '42; November 1984; Bryn Mawr, Penn.
Howard W. Comey, '43; 1984; South Acton, Mass.
Howard Weaver, Jr., '44; 1983; Phoenix, Ariz.
Edmond J. McClure, Jr., '45; 1983; Blasdell, N.Y.
James W. Shearer, '45; October 9, 1984; Livermore, Calif.
Charles H. Tavener, Jr., '45; Jauary 17, 1982; Boca Raton, Fla.
James W. Church, '46; 1983; Silver Spring, Md.
Norman P. Hobbs, '48; October 17, 1984; Chestnut Hill, Mass.
George H. Bradley, Jr., '49; April 19, 1984; Albuquerque, N.M.
Wilmer S. Garwood, Jr., '50; December 8, 1984.
Ben Silver, '50; 1982; Barrington, R.I.
James B. Law, '52; 1984; New Delhi, India.
Vernon V. Hukee, '56; September 26, 1984; Nashua, N.H.
William L. White, '59; January 21, 1985; Newtonville, Mass.
Mohammad R. Damghany, '62; December 22, 1984; Arlington, Mass.
William G. Margetts, '62; 1984; Cambridge, Mass.
Edward Terner, '65; September 27, 1984; Shelburne, Vt.
Louis J. Urban, '70; October 31, 1984; Kettering, Ohio.
James S. Steil, '80; December 20, 1984; Moses Lake, Wash.

ALLAN J. GOTTLIEB

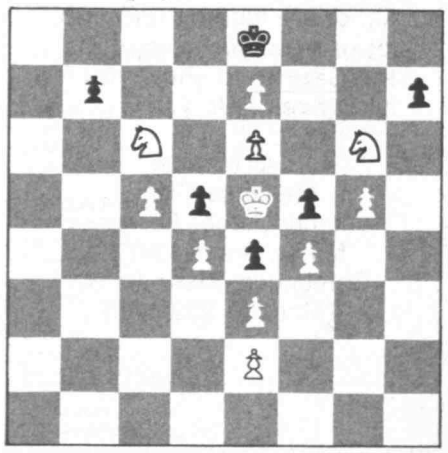
Can You Find the Bad Penny in the Bank?

Just as I am writing this the mailman has brought a letter from the New York State Crime Laboratory marked "official business." After two gulps and one reflection as to what I could have done that they found out about, I got up my courage to open the envelope and was relieved to find it was just a "Puzzle Corner" reader responding to several problems from the January issue.

As I have remarked previously, Nobuyuki Yoshigahara selected me as "World Puzzlist" No. 8, and now he has forwarded the issue of *Quark* in which this honor was officially bestowed. In addition to being flattered, I enjoyed hearing the transliteration of "Gottlieb" when one of my Japanese-speaking colleagues read the beginning of the column. Thank you again, Mr. Yoshigahara. I should also mention that long-time "Puzzle Corner" contributor, Richard Hess, was selected World Puzzlist No. 6.

Problems

APR 1. I read our first problem for this month in *net.chess*, an electronic newsgroup devoted to chess. Roughly speaking, these newsgroups consist of widely separated individuals who communicate with each other via electronic mail. I especially enjoyed the following two-part offering from Jeffrey Mattox, who noted that it is possible, albeit unlikely, for the position to occur in a game:
White is to play and mate in two. Mattox notes that at first glance there appears to be two possible solutions. You are to show that only one meets the need.



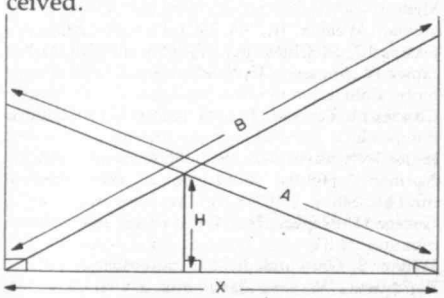
APR 2. Our next problem is from Phelps Meaker, who first asks you to study:
16601.92 + 14374.08 =
11334.4 + 19641.6 =
18521.44 + 12454.56 =
4147.36 + 26828.64 =
He then notes that each pair is a different way of evaluating the same equation and asks you to write the equation in the usual form. He also offers a hint, but you may wish to try the problem without this aid. [*The hint is to note which three numbers are perfect squares.*]

APR 3. Rich Decker wants you to find all maxima and minima of

$$\frac{\ln(1 + e^{-x}) + \frac{x}{2}}{\ln(1 + e^{x}) - \frac{x}{2}}$$

without using any calculus. This problem appeared in an Ohio State University prize exam for undergraduates.

APR 4. Allan Faller wants us to be penny wise and writes:
On each day of the year (not leap year) you are given a penny. On December 31 you are given your last penny and told that it was fresh from the U.S. Mint, but that one of the previous pennies may have been counterfeit, and therefore lighter or heavier than the standard penny. You are asked to determine the number of balancings, using a common pan balance, that would be necessary and sufficient to determine whether or not there is a counterfeit coin, and if there is, to tell whether it is heavier or lighter than the last penny that you received.



APR 5. Our final regular problem, from Martin Brock, is based on the familiar "crossed ladders" configuration at the bottom of the previous column:
Mr. Block asks you to find X for two configurations. First when A = 15, B = 10, and H = 8; and second when A = 16 + 2√2, B = 16 − 2√2, and H = 2.

Speed Department

SD 1. A bridge quickie from Doug Van Patter:
North:
♠ K 8 5 4
♥ Q 10 7 4
♦ 5 3
♣ A Q 10
South:
♠ A 9 3
♥ —
♦ A Q 6
♣ K 9 8 7 6 4 3

East:	*South*:	*West*:	*North*:
1S	2C	P	3C
3H	5C	P	P
5H	6C	D	P

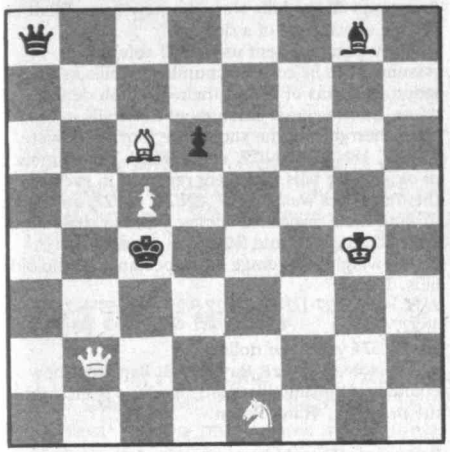
Instead of defending the usual five-heart bid by East, you (South) make the aggressive bid of six clubs. West opens with ♥5, which draws the ♥10, ♥K, and a trump. You lead a club to dummy's ♣A and East shows out. Your finesse of the ♦Q loses to West's ♦K, and West returns a trump to the ♣10. You lead to the ♦A (East shows out), and ruff your third diamond with dummy's last club. Can you find a way to justify your overbid? (East is an excellent player, never known to psych).

SD 2. Joseph Horton writes: Great news! I have answered an age-old question: Which came first—chicken or egg?

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, ASSOCIATE RESEARCH PROFESSOR AT THE COURANT INSTITUTE OF MATHEMATICAL SCIENCES, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y., 10012.

Solutions

N/D 1. White, moving first, is to mate in three moves:



Howard Stern found this problem to his liking: The following three plays represent the only possibilities resulting from White's initial move:

White:	*Black*:
Q-c2	K-b4
Kn-d3	K-a3
Q-b2 mate	

White:	*Black*:
Q-c2	K-d4
Kn-f3	K-e3
Q-d2 mate	

White:	*Black*:
Q-c2	K-b4
Kn-d3	K-a5
Q-a2 mate	

Also solved by Eric Rayboy, David DeLeeuw, R. Bart, Benjamin Rouben, Matthew Fountain, Steve Feldman, Ronald Raines, Elliott Roberts, and the proposer, J. Weatherly.

N/D 2. Find a number that equals its own logarithm.

There is no positive real number x such that either $\log_{10}(x) = x$ or $\log_e(x) = x$. Several readers, including the proposer, Smith D. Turner ($\int dt$), went on to consider $\log_a$. However, I do not feel this meets the conditions of the problem (note that logarithm was used in the singular). Tim Maloney (and others) made another generalization; he writes:

First, one must recognize that the solution is a complete number, call it $Z = u + iw = re^{i\theta}$

Then

$re^{i\theta} = \ln(re^{i\theta})$

$r\cdot\cos\theta + ir\cdot\sin\theta = \ln(r) + i\theta$, or

$\ln(r)/r = \cos\theta$

$r = \theta/\sin\theta$.

We must therefore solve

$\ln(\theta/\sin\theta) = \theta\cdot\cot\theta$.

An iterative solution gives

$\theta = 1.337236\ldots$, so

$Z = (1.374557\ldots)e^{(i1.337236\ldots)}$

$= (.3181313\ldots) + i(1.337236\ldots)$.

I must admit that I first saw this problem in my junior year at M.I.T. (1970), when someone propose' the problem in a lunchtime discussion in Professor Daniel Kleppner's research group. Kleppner immediately drew a graph on the board to prove the solution could not be real, asserted that it must be complex, and left us all speechless.

Also solved by Eric Rayboy, R. Bart, Matthew Fountain, Ronald Raines, Winslow Hartford, John Spalding, John Woolston, Naomi Markovitz, Mike

Hennessey, Frank Carbin, Greg Huber, Avi Ornstein, Oren Cheyette, John Prussing. Edwin McMillan, Charles Sutton, and the proposer, Smith D. Turner (∫dt).

N/D 3. Given a floor lamp with two bulbs, in which each socket has a chain which when pulled will change the on/off state of only the bulb in that socket. When the lamp is on, it is difficult to determine whether one (and if so which one) or both bulbs are on. The problem is to find the shortest sequence of pulls that will turn the lamp completely off sometime during the sequence (e.g, if chains are labeled A and B, AABBAB fits the requirements, but a shorter sequence may be found). Can you generalize your solution to a lamp of three bulbs, four bulbs, etc.? Is your solution unique?

The following solution is from John Spalding:

The solutions can be generated recursively starting with the solution for the trivial case of one bulb. Suppose we number the bulbs 1, 2, 3 . . . instead of lettering them. Then the solution for n bulbs could be given as the following function f(n) giving a sequence of numbers:

$f(1) = 1$

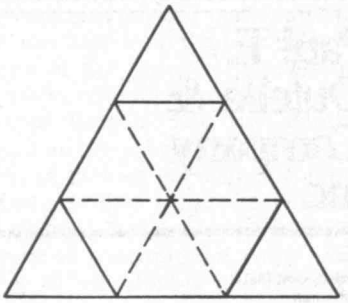
$f(n) = f(n - 1), n, f(n - 1)$

For two bulbs, the solution is thus 1,2,1 or ABA: for three bulbs, the solution generated would be ABACABA; for four, ABACABADABACABA, etc. When the chains are pulled in this sequence, the bulbs will cycle through what I think is called a Gray Code, in which all the possible n-digit binary numbers are generated by only changing one digit at a time. The number of steps required for n bulbs is thus $2^n - 1$, which is what we would expect. Is the solution unique? Well, no. Multiple working sequences may be generated by simply permuting the bulbs' labels—e.g., ABA and BAB. In addition, labels may be permuted at intermediate levels of the recursion—e.g., ABACABA and ABACBAB are working sequences for three bulbs.

Also solved by Eric Rayboy, R. Bart, Matthew Fountain, Winslow Hartford, John Woolston, Naomi Markovitz, Mike Hennessey, Frank Carbin, Oren Cheyette, Pat Kinney, Mike Strieby, Harry Zaremba, Howard Stern, Yokichi Tamaka, and Joe Feil.

N/D 4. A regular hexagon can be inscribed in an equilateral triangle so that its alternate sides coincide with the sides of the triangle. What is the ratio between the areas of the hexagon and the triangle?

Walter Cluett has little trouble with this one: Divide the hexagon into six equilateral triangles and the answer is 6 to 9 or 1 to 1 1/2.



Also solved by Eric Rayboy, R. Bart, Steve Feldman, Howard Stern, Ronald Raines, Winslow Hartford, John Spalding, John Woolston, Naomi Markovitz, Mike Hennessey, Frank Carbin, Greg Huber, Avi Ornstein, Pat Kinney, Harry Zaremba, Frederic Jelen, Ruben Cohen, Stefan Habsburg, Peter Silverberg, George Byrd, James Reswick, Dick Robnett, Raymond Gaillard, Michael Lamoureux, Mary Lindenberg, Smith D. Turner (∫dt), and the proposer, Phelps Meaker.

N/D 5. In the country of Moolah, the national bank issues new dola bills to replace each bill that wears out or is lost or destroyed, so there is always a constant number of dolas in circulation. On January 1, the bank issued a new bill with the picture of Prince Centime replacing that of the late Queen Peseta. After one year, they found that 10/27 of the bills in circulation were the new variety. After two years, 2/3 of the bills; and after four years all the bills were the new type. What is the life expectancy of a dola bill?

Harry Zaremba sent us a lucid solution: Assume N to be constant number of bills in circulation. In terms of N and their common denominator, the fractional amounts of new bills in circulation during the successive four years were 10N/27, 18N/27, 24N/27, and 27N/27. The number of old-variety bills that were replaced in each of the four years was 10N/27, 8N/27, 6N/27, and 3N/27, and their respective *average* years in circulation were 1/2, 3/2, 5/2, and 7/2 years per dola. Let A be the weighted average life expectancy of the old bills. Then,

$A \cdot N = 10N/27 \cdot 1/2 + 8N/27 \cdot 3/2 + 6N/27 \cdot 5/2 + 3N/27 \cdot 7/2$, or

$A = 1.574$ years per dolla.

Also solved by Eric Rayboy, R. Bart, Matthew Fountain, Winslow Hartford, Frederic Jelen, and the proposer, Frank Rubin.

Better Late Than Never

Y 1984. Claes Wihlborg and Mats Ohlin have responded.
M/J 1. R. Bart found two alternative solutions.
JUL 3. Smith D. Turner (∫dt) found a simpler solution strategy.
A/S 1. Samuel Levitin and Benjamin Rouben have responded.
A/S 2. Samuel Levitin has responded.
OCT 1. R. Bart, W. Smith, and Richard Hess have responded.
OCT 2. R. Bart has responded.
OCT 3. R. Bart, Samuel Levitin, Richard Hess, and R. Morgan have responded.
OCT 4. R. Bart, Richard Hess, Samuel Levitin, Phelps Meaker, and Altamash Kamal have responded.
OCT 5. R. Bart has responded.
N/D SD 1. Michael Strieby and Dick Robnett found alternate solutions.
N/D SD 2. The correct answer is 8, as noted by Eric Rayboy, David DeLeeuw, R. Bart, Winslow Hartford, John Spalding, John Woolston, Naomi Markovitz, Pat Kinney, Mike Hennessey, Mike Strieby, Frederic Jelen, Ruben Cohen, Stefan Habsburg, Peter Silverberg, George Byrd, James Reswick, Dick Robnett, Mike Ober, Walter Cluett, Roger Allen, Harry "Hap" Hazard, Peter DeFoe, Victor Christiansen, W. Katz, and Phelps Meaker.

Proposers' Solutions to Speed Problems

SD 1. East has 12 cards in the majors, most likely 6-6-1-0. She needs the ♥A for her opening bid. In order to get back to your hand to draw the last trump, you must *not* play a spade! (1) It may be trumped (true!), and (2) You need the ♠A to execute a so-called "simple" squeeze play. (What squeeze is simple at the table?). Ruff a heart and play all your trumps but one, reaching this four-card position:

North:
♠ K 8 5
♥ Q

East:
♠ Q J 10
♥ A

South:
♠ A 9 3
♣ 3

After you play your last club, discarding a spade from dummy, East is rendered helpless.

SD 2. The egg. The first egg from which a chicken hatched had to have been laid by the immediate evolutionary ancestor of the chicken. On the other hand, the first chicken laid something like what we have for breakfast—what else, a dinosaur egg? Please forward all correspondence to the Nobel Institute in Stockholm, Sweden. I'll be waiting for it there.

for public affairs at Exxon Corp. The errors they cite were made during the editorial process. We apologize to authors Petroski and Johnson, and to readers San Miguel and Lewis.—Ed.

Bring on the Minicar

In "Moving People and Goods Before the Year 2000" (*May/June, page 60*), David Gordon Wilson mentions a study underway on the design and use of new two-passenger cars. However, data from a full-scale, real-world test of such a minivehicle are already available for anyone to collect and analyze.

In 1972, I purchased a brand new Honda 600 minisedan. Its list price was $1,400 when a Ford Pinto sold for $2,000. It weighed 1,450 pounds empty; had a 2-cylinder, 600-cubic-centimeter (about 37-cubic-inch) engine; and could seat four adults, although the back seat was definitely cramped. Acceleration was poor, but the car could cruise on interstate highways at the then-legal speed of 70 miles per hour. The vehicle exceeded 40 miles per gallon on long trips back when gas was 33 cents a gallon. Although the small body and 10-inch wheels made it look miniscule, I frequently drove it on logging roads and it had only one inch less ground clearance than a four-wheel-drive Ford Bronco.

The next year, Honda stopped importing the 600 in favor of the much-larger Civic, and Subaru and Suzuki also stopped importing their 600-cubic-centimeter and smaller cars. Yet several thousand of these minicars are probably still on the road after a dozen years of use, and probably a million Americans have driven one. Although these people are somewhat self-selected, they still provide a much broader sample than any research group chosen to test a new car. Unfortunately, the present quotas on auto imports make it unlikely that large numbers of small, cheap cars will will be imported any time soon.

Roy R. Schweiker
Concord, N.H.

Correction

"A Common Sense Approach to Nuclear Waste," by Victor Gilinsky (*January, page 14*), continues on page 59 of that issue.

ILLUSTRATIONS: ELIZABETH SLOTE

UTOPIA: Where Workers Craft New Technology

THE sign on the door reads "technical laboratory." The walls are festooned with elaborate diagrams. In one corner a slide carousel projects images onto a small, VDT-sized screen, simulating a computerized work station in operation. In another corner, an individual puts together the photographs, headlines, and text of a newspaper page on the screen of a real terminal. At his side an observer jots down a few notes and asks an occasional question about the quality of the "interface" and the "feel" of the machine.

It could be a scene from the research department at any high-tech computer manufacturer. But this lab is in the government-funded Swedish Center for Working Life in Stockholm. The individual using the terminal belongs to the Swedish Graphics Workers Union, while his partner is a computer scientist from Sweden's Royal Institute of Technology. Both worker and scientist are participants in an intriguing experiment in technology development known as the UTOPIA Project.

UTOPIA is a Swedish acronym for "training, technology, and products from a skilled worker's perspective." It is a three-year, $400,000 research effort, funded primarily by public sources, that has brought together two quite different social groups: on the one hand, systems designers, computer scientists, and work-efficiency experts at institutions in Sweden and Denmark; and on the other, activists and officials from unions representing some 120,000 printers, typographers, lithographers, and other skilled workers in the newspaper and printing industries of the five Nordic countries.

Since 1981, UTOPIA participants have worked to define a role for trade unions in the design of new workplace technology. The goal is to help unions translate their social values regarding job skills, quality of work, and quality of products into new computer hardware and software for the printing industry. In this way, participants hope to shape the impacts of new technology on workers before it ever reaches the shop floor.

Few Americans would expect unions to play an active role in developing new technology. The most common stereotype is that workers oppose it through restrictive work rules, feather-bedding, and even a Luddite resistance to the very idea of technological change. But the reality is considerably more complicated. While unions have often tried to cushion their members from the negative impacts of new technology, few have flatly opposed it. Especially since the end of the Second World War, most U.S. unions have chosen to accept management's plans for new technology, and then bargain over their share of the productivity gains that technology can make possible.

In a pioneering Scandinavian project, printing unions are helping to design new computerized equipment. The plan promises payoffs for workers, managers, and designers of new technology.

BY ROBERT HOWARD

This attitude may now be changing for two basic reasons. The computer has transformed work on a scale not seen since the mass-production assembly line was introduced at the turn of the century. What's more, this technological change is occurring as a profound restructuring of the world economy has brought increased international competition and higher levels of unemployment to most advanced industrial economies.

As a result, trade unions—primarily in Europe, and to a lesser degree in the United States—have begun to ask several fundamental questions: What is the impact of the microelectronics revolution on employment? How does the ongoing computerization of work affect employees' skills and job quality? What are the potential health effects of the new technology? How can workers acquire the training to ensure that the computer revolution does not pass them by? And, perhaps most important, how is rapid technological and economic change reshaping the traditional balance of power between corporations and unions?

Nowhere has union activism on these issues gone further than in Scandinavia. Beginning in Norway in the late 1960s, and extending to Denmark and Sweden over the next decade, technical specialists from government-funded institutions such as the Norwegian Computing Center in Oslo and the Swedish Center for Working Life joined unionists to study the effects of new technology on work and to formulate realistic union strategies to address them.

These "action research" projects spread throughout Scandinavia in metalworking shops, chemical refineries, railroad repair shops, insurance offices, retail stores, and newspaper offices. They quickly took on the form of a popular-education movement. Workers began to understand technology as something they might be able to influence—just like other aspects of working life. And technologists began to see some of the implications for people on the shop floor of the technologies they designed. They began to question some of the assumptions and methods of their profession.

Perhaps most important, action research has enabled workers to participate in company decisions about technological change. In Norway, for example, the projects have led to a new kind of collective-bargaining mechanism known as "technology agreements." These give local unions the right to receive advance notice of all company plans for purchasing or designing new technical systems, and to appoint a union staff member to represent workers' interests in all technological matters. UTOPIA represents the most recent effort by Scandinavian unions to deal with new technology: building union influence over the design of technology itself. UTOPIA focused on the printing industry.

How Computers Transformed Printing

Printing has traditionally been considered the archetypal craft industry. In his sociological classic *Alienation and Freedom*, written in 1964, Robert Blaunder described how the combination of "craft technology, favorable economic conditions, and powerful work organization and traditions" gave printers "the highest levels of freedom and control in the work process among industrial workers today." Yet in the past two decades, the introduction of computerized text-entry, typesetting, and layout have transformed both the industry and workers' roles within it. At the same time, newspapers, in particular, have faced intense competition from alternative advertising outlets, including television and the new mass-circulation "daily shoppers."

The most visible impact of such technological change has been on the number of jobs. Employment of production workers in the U.S. printing industry declined by perhaps 50,000 through the 1970s. Computer and telecommunications technology has also made it easier for companies to shift work from heavily unionized and relatively high-wage urban centers in the Northeast to nonunion printing shops in other parts of the country.

Those printers who remain have experienced far-reaching changes in their autonomy and creativity. Obviously, the keyboards, terminal screens, and software of computerized systems require altogether new skills. Workers have suddenly found themselves dependent on their employers and computer companies for new training in the tools of what, for generations, they had considered "their" trade. Computerization has also created conflicts over job definitions in what Scandinavian printers, borrowing a metaphor from soccer, like to call "the struggle for the mid-field."

Such changes sometimes result from the capabilities of the technology itself. Reporters can now type their stories directly into the computer system, which automatically typesets them and eliminates the need

for many skilled typographers. In other cases, the technology provides a smokescreen to disguise what are really managerial decisions about how to organize work. For example, computerized layout systems have allowed several newspapers to shift work from union printers to other company employees.

Computerization has also brought more subtle changes to printers' work. In the days of lead, skilled craftspeople made up an entire page of articles, headlines, photoengraving, and advertisements in metal, according to a rough sketch provided by the editorial department. Because they could "put their hands on it," makeup workers could easily judge the quality of their design.

Lead was succeeded by paper, with workers pasting columns of text onto page boards. Although pages lose a certain crispness of detail during this process, makeup workers can more readily rearrange and evaluate the elements of the page.

With computerization, makeup workers' relationship with the page has changed drastically. Early systems made layout extremely abstract, and some still do not show the page on the terminal screen. They require the workers to retain a mental image of the page while they feed codes into the computer that instruct it to create certain shapes and spaces on the page. More recent systems do show empty boxes on the screen representing headlines, articles, and photographs. But makeup workers still have difficulty judging page design because they do not work with the actual pictures or text. "It's almost as if you were working blind," says Malte Ericsson, a Swedish lithographer and participant in UTOPIA.

The new computer technologies, Scandinavian printers argue, have diminished the quality of the product as well as that of their work experience. European newspapers have traditionally been far more design conscious than their American counterparts. They use higher-quality newsprint, a greater variety of typefaces, and more color, graphics, and special photography. Computerization, unions claim, has brought standardization—a trend toward a more boxy "American" style based on uniformity of typeface and monotony of design. The ultimate result is visually less interesting.

Some computer systems make layout so abstract that "it's almost as if you were working blind."

This change is not the inevitable outcome of computerization. One need only look at a newspaper such as *USA Today* to see how state-of-the-art technology can allow newspapers to explore new frontiers in design. However, according to the Scandinavian printers' unions, many papers in the rush to automate seem to have eliminated not only workers' craft autonomy but also some fundamental principles of graphics design.

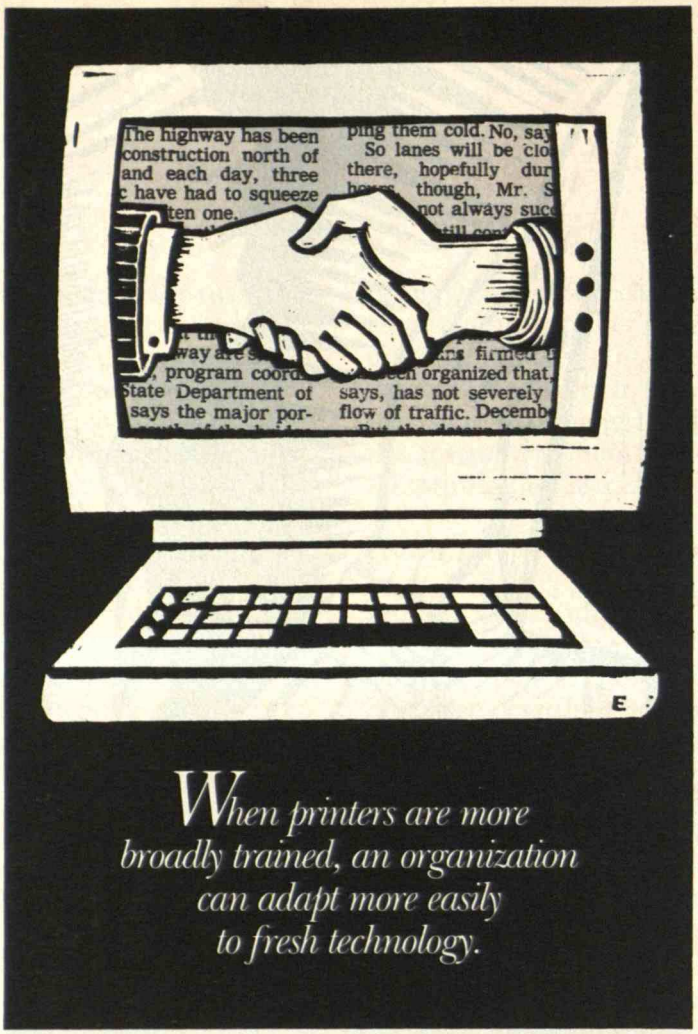
The Unions' Alternatives

Such concerns have made technological change in the printing industry a divisive process in a number of countries. The New York City newspaper strike of 1963 and the *Washington Post* conflict in 1975 stemmed from the advent of new technology. Many unions have also resorted to less aggressive measures to protect their members from the negative consequences of technological change. In Britain, for example, labor has negotiated a ban on "single key stroking"—the automatic typesetting of text that journalists enter into the computer. Thus, after writers compose their stories at a terminal, a paper copy must be made. A union typographer then retypes the copy into the computerized typesetting system.

In the Nordic countries, the conflict has taken a different course. While print unions have negotiated

protective measures similar to those in other countries, their participation in the action research projects taught them that such an approach can, at best, be a holding action. "The real issue," says Malte Ericsson, "is determining how we can make sure that no single occupational group is totally expelled from the profession. To do that, we have to suggest alternatives."

That is where the design of technology becomes important. "We saw the big printing companies and newspapers doing their own research," says Gunnar Kokaas, secretary of the Norwegian Graphics Workers Union. "They were giving money to vendors to develop new equipment that we felt would undermine our traditional labor agreements. So we thought it was important for us to get into R&D as well, to support technology that would lead to the kind of skills and working conditions that *we* were interested in. Maybe that way we could influence the vendors."



When printers are more broadly trained, an organization can adapt more easily to fresh technology.

Scandinavian unions had already tried this approach in a more limited way. During the 1970s, they were among the first to urge VDT manufacturers to apply strict "ergonomic"criteria to reduce strain on the human body caused by prolonged VDT work. By the early 1980s, Nordic computer companies were making some of the world's most ergonomic terminals. They had also become the most vocal proponents of adhering to such design standards, seeing in them a potential competitive advantage akin to the rigorous safety features of Volvo automobiles.

In effect, the unions were able to establish a set of standards for the entire VDT marketplace. UTOPIA set out to do the same for the technology of the entire printing industry.

UTOPIA's computer scientists were convinced that recent technological advances could benefit skilled printers. For example, powerful new software could create an accurate facsimile of the printed page directly on the terminal screen. This made it possible to create electronically the immediate feedback that makeup workers previously enjoyed using manual methods. Such capabilities could begin to restore printers' traditional autonomy and control. Instead of simply "automating" work previously done by people, the computer could augment printers' design skills, becoming, in the words of UTOPIA director Pelle Ehn, "an advanced tool for skilled graphics workers."

Seeing the computer as a tool also implies a different understanding of the process by which new technical systems are developed. Most designers create a highly abstract model of a work process, and then try to incorporate that model into new computer hardware and software. Often, workers using the system end up as little more than passive objects of automation. UTOPIA's goal was to put the centuries-old traditions and occupational knowledge of printers at the center of the design process. Workers would play an active role in determining what kind of technology they needed and how it could support them in their work.

This did not mean preserving activities performed by printers in the past. As Pelle Ehn says, "When a worker used lead he had to have the skill of reading upside down and backwards. Is that a skill one should want to protect? Probably not." However, UTOPIA would maintain printers' ability to create an attractive page design. "That is the kind of skill you have to make sure not to destroy when you shift to new technologies," says Ehn.

The group discovered early on that the best way to articulate printers' demands for new technology was to give them direct experience using it. Since UTOPIA had no money to set up its own computerized printing shop, the project team opted for the

next best thing—ever more sophisticated simulations of the page makeup process.

At first, participants used crude styrofoam and plywood mockups and paper diagrams to map out the steps of page makeup. Later, the team rigged up a slide projector that flashed makeup images onto a screen representing a computer terminal. By rearranging the order of the slides, the team could experiment with different ways of organizing the makeup process. Ultimately, the lab acquired a real computer work station, programmed with a few sample layout functions, that helped the team refine its ideas for hardware, software, and organization of work. As printers discussed the pros and cons of different approaches, the technical staff advised them on their feasibility.

Developing the Technical Compromises

Had this been the extent of the UTOPIA Project's work, it would have remained an interesting but somewhat abstract research project. However, in 1982, Sven Holmberg, the president of Liber Systems, made a proposal that helped turn UTOPIA into a concrete exercise in technological development. Liber was the chief participant in a $10 million Nordic project to develop a fully integrated text-and-image processing computer system known as TIPS. Based on technology developed at Sweden's University of Linköping, TIPS was to be one of the most sophisticated computer systems available in the printing and publishing industry. It would combine text entry, image enhancement, pagination, and layout in a single work station.

Holmberg offered UTOPIA a role in the Liber development process. Project participants agreed to produce a set of "applications specifications" recommending how the Liber system should be used in printing. In exchange, the project acquired access to the TIPS technical staff and R&D labs. For Liber, cooperation with UTOPIA offered a way to incorporate users' ideas into the new system, although the company was not required to do so. For UTOPIA cooperation offered an opportunity to influence a specific technical system soon to reach the market.

Completed last year, the UTOPIA specifications try to strike a balance between workers' demands and technical capabilities. For example, one of the printers' top priorities is gaining the capacity to work with an entire newspaper page directly on the terminal screen. However, even the largest screens are too small to present a newspaper page in its normal size. Either the page must be reduced, making the text and the images too small to be seen clearly, or only a portion of the page can be projected on the screen, disrupting workers' sense of the whole.

The technical compromise developed by UTOPIA and TIPS engineers recommmends software that provides makeup workers with "lenses," or "viewports," through which they can see different portions of the newspaper page. Different lenses allow scale reduction, magnification, or natural size. If workers want to change some text, they might use the lens that presents that portion in its natural size. But if they are assembling articles, headlines, and photographs into an overall design, they can chose the lens that reduces the whole page to fit on the screen. Makeup workers can also use different lenses simultaneously. They might enhance a photograph or drawing to full scale in one corner of the screen while watching the impact of this operation at a reduced scale on another part of the screen. Or they could compare different versions of the same page on the screen simultaneously.

The UTOPIA specifications also call for workers to have access to high-speed laser printers. These create hard-copy prints of layouts that allow the workers and their editors to check the design created with the computer in terms of how it will look on the printed page.

The specifications further touch on organization and training. The "scanner station," where a worker feeds photographs and graphics material into the computer, provides an example. UTOPIA recommends that the system allow workers to begin preparing photographs for layout in addition to simply feeding the information to the computer. This makes the job more varied and helps to avoid bottlenecks at later stages of production.

Finally, whereas most vendors train users to operate only their particular system, UTOPIA recommends that training include general education in what Pelle Ehn calls "computer science for graphics workers." Such training can yield dividends for management. When printers are more broadly trained, an organization can adapt more easily to fresh technology. And the more understanding workers have of the concepts underlying the systems they work with, the more they will be able to exploit the systems' versatility to create high-quality products. Pelle

Software developed in a cooperative project equips terminal screens with "lenses." These enable makeup workers simultaneously to view text and photographs at full size and to judge their appearance on a newspaper page scaled down to fit the screen. Workers can also compare different versions of the same page.

Ehn even foresees a not-too-distant time when powerful new software packages will enable printers to program systems themselves in order to maintain, upgrade, and adapt their technology to new uses.

Practical Problems

Liber unveiled its TIPS technology last spring. Six out of nine systems ordered so far are being installed, including two at newspapers in Finland and Sweden. Not surprisingly, in the move from technical lab to newspaper shop floor, UTOPIA's ideas have encountered some obstacles. How they are met will determine UTOPIA's ultimate impact. Indeed, the most important period for the UTOPIA Project may still lie ahead.

Creating new models for designing technology and organizing work does not guarantee that employers will actually use them. While Liber has incorporated many of the UTOPIA recommendations for user-friendly software into its system, the company has left most of the ideas concerning work organization and training up to individual customers. Thus, the precise impact of the TIPS technology on graphics workers in any given company will depend upon a complex process of formal and informal negotiations. Here the goals of the UTOPIA team can clash with those of other social groups.

One example is the introduction of the TIPS technology at the Stockholm daily *Aftonbladet*. Originally, UTOPIA members were to have helped define how the new system would be used at the newspaper. However, *Aftonbladet* management, anxious to implement the new system, refused to let the UTOPIA team participate. The local journalists' union—leery of what its members saw as the "graphics workers' technology"—also opposed UTOPIA's role. Thus, the project's concepts became hostage to traditional conflicts between unions and management and among unions.

UTOPIA's model of skilled workers using high technology to create high-quality products may also encounter problems with general trends in the newspaper industry. While the UTOPIA team was refining its concepts in the technical laboratory, U.S. manufacturers were perfecting a different approach to computerized pagination known as "free-flow page makeup." This allows editors to perform both page layout and copyediting. To remain competitive, especially in the U.S. market, Liber has had to include this feature in TIPS.

But how TIPS or any computerized pagination system is used in the Scandinavian printing industry will ultimately depend, at least in part, on how well the graphics workers' unions argue for their own model of technology and work. Perhaps UTOPIA's greatest accomplishment has been its contribution to workers' expertise about technology and its impacts. This knowledge is already affecting the outcome of labor-management negotiations in the printing industry. Malte Ericsson tells of entering negotiations with the managers of a Stockholm printing firm who wanted to introduce a new Xerox laser printer. Because of his involvement with UTOPIA, Ericsson found that he knew far more than his

PHOTOGRAPH: LIBER SYSTEMS

Lively design has traditionally played a major role in European newspapers, such as Sweden's Aftonbladet. Scandinavian printing unions fear that computerization of makeup may lead to standardized, monotonous designs. A major goal of the UTOPIA project is to maintain high design standards by using appropriate software.

counterparts across the bargaining table about the system's labor requirements, the kind of skills workers would need to operate it effectively, and the type of training they would require. "We feel we are stronger in negotiations now," says Ericsson, "because we have more knowledge than the employers."

Last November, the UTOPIA specifications were used in national negotiations for the first time, forming the basis for proposals by the Danish Graphics Worker Union on new technology. And so seriously does Sweden's newspaper-industry trade association take the new union proposals that it is developing its own "system specifications."

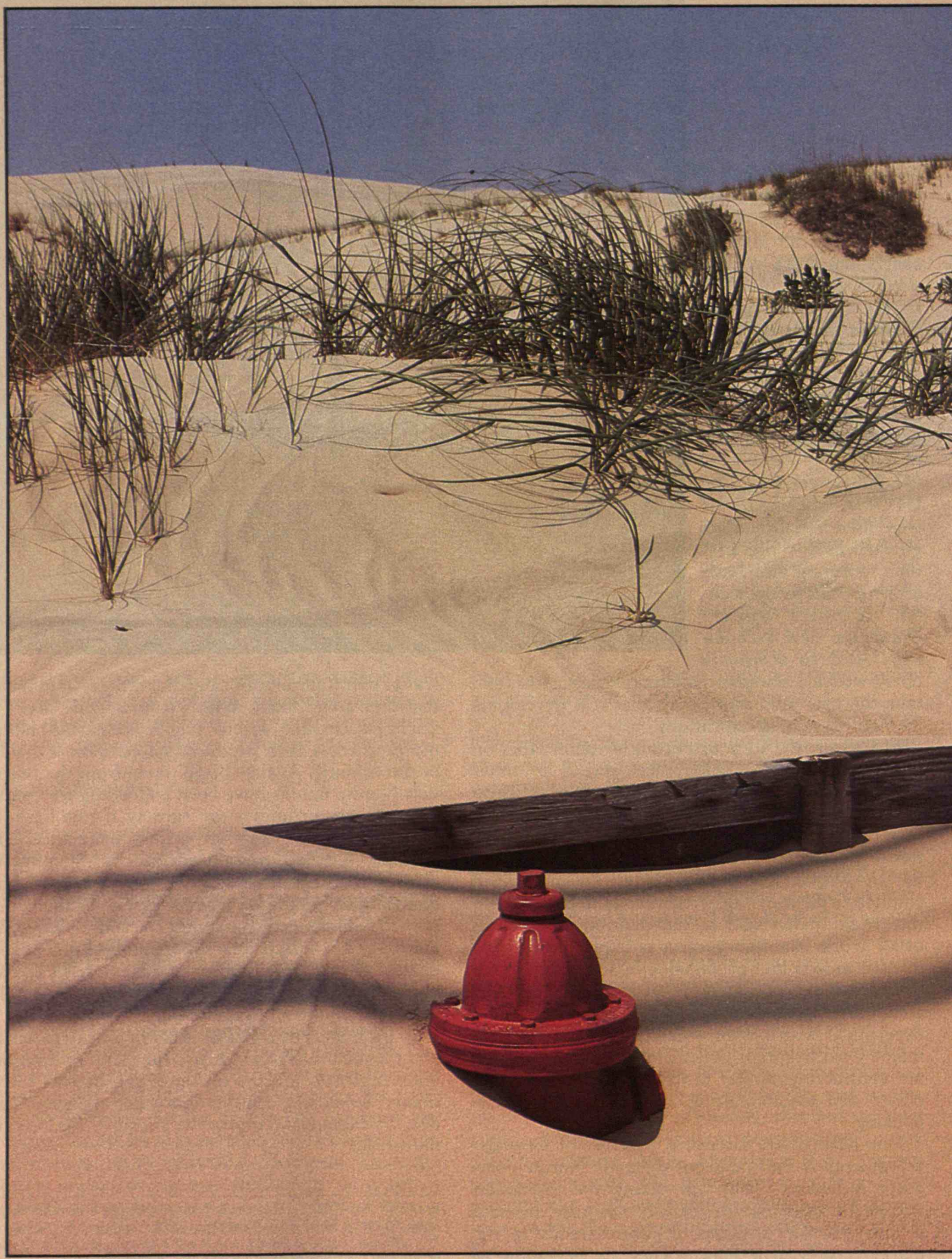
Moreover, the idea of putting a union label on new workplace technology has spread to other Nordic unions. Those representing office workers have recently announced an effort to create their own organizational model for the "office of the future." According to project director Arne Pape of the Norwegian Computing Center, the model will emphasize the use of new technology to break down the traditionally rigid sexual division of labor in office work. Another project is exploring how to involve unions and professional associations in the design of "expert systems"—programs that enable a computer to make judgments. A preliminary field experiment with nurses is currently underway at a major Oslo hospital. Other unions and researchers are considering similar projects in computer-aided design and manufacturing, retail sales, and warehousing.

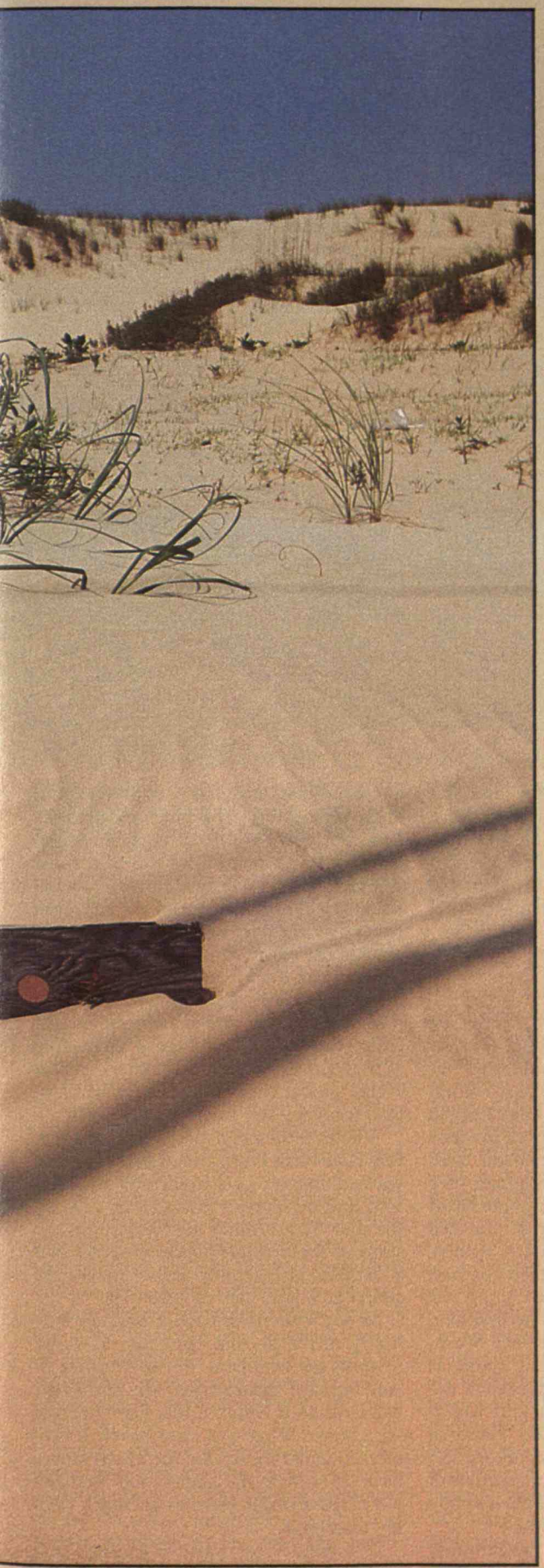
One particularly interested observer of these developments is the small but dynamic Nordic computer industry. "They are taking the discussion within the labor movement very seriously, because it may provide a signal of future trends in the market," says Arne Pape. "They are beginning to realize that trade unions can point things out to them that they aren't likely to hear from anyone else."

The discussion within the Scandinavian labor movement has even produced an echo on this side of the Atlantic. As they begin to confront the issues that Nordic unions have been addressing for years, some American unions are turning to the Scandinavian labor movement for models and advice. For example, last September, leaders of the Communications Workers of America (CWA) went to Scandinavia with executives from AT&T to examine the way the unions and companies are addressing technology and its effects on work. Explains Lorel Foged of the CWA's Development and Research Department, speaking of UTOPIA, "We'd love to be able to do something along those lines."

So the impact of UTOPIA is continuing to expand, and the idea that workers and their unions have an important role to play in the design of new technology is reaching a wider and wider audience. Today, Scandinavia. Tomorrow, perhaps, the rest of the world.

ROBERT HOWARD writes on work and technology from Cambridge, Mass. His book Brave New Workplace *will be published by the Viking Press this fall.* *Research for this article was supported in part by a travel grant from the German Marshall Fund of the United States.*





The constantly shifting sands of barrier-island beaches show no respect for human developments.

The Restive Beaches

BY FRANK LOWENSTEIN

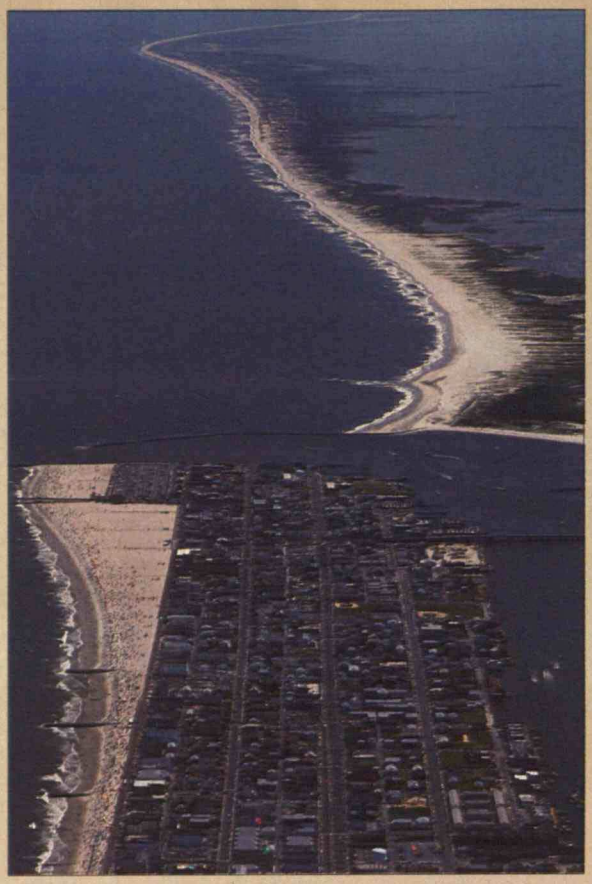
At 5 A.M. on March 29, 1984, Ron Gilmartin awoke to the news that Seabright, N.J., was in danger. By 7 A.M., Gilmartin, coordinator of the Monmouth County Office of Emergency Management, was supervising the evacuation of Seabright, along with nearby Highlands and Monmouth Beach, as last winter's worst storm pounded the beachfront communities. By afternoon, Gilmartin grew even more worried. "If the storm continued through the night as predicted, I knew I probably would lose seven or eight towns—under water," he recalls. At the last minute the storm turned aside. "It could have been ten times worse than it was that night," he says.

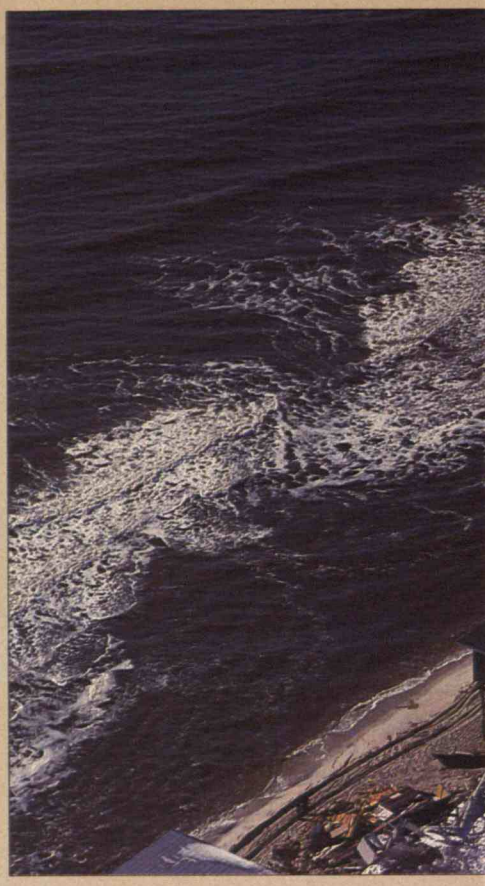
But in Seabright—built on a thin strip of sand separated by water from the mainland and protected from the Atlantic by a great seawall—things were bad enough already. Driven by 70-mile-per-hour winds, the ocean came right over the wall and rushed through the town. "I've lived here all my life and know a lot of old-timers, and they say they'd never seen water so deep or seen it come in so fast," says Police Chief Kenneth Johnson.

In Monmouth Beach, Lucy Engstrom, age 80, watched the ocean fill up her usually quiet street and then begin to slip under her front door. "All I could do was watch the water come up," she remembers. "I really felt that I wouldn't make it." When rescuers finally arrived, she was perched on top of her furniture with water swirling at the hem of her dress. Engstrom's home still "looks like a shooting gallery" but, she adds with a wry twist, "at least I didn't get any fish in the house."

From Maine to Texas, the fragile yet vital barrier islands are under attack. The villains: rising seas, increasing development, and quick-fix engineering.

PHOTOGRAPH: RUNK/SCHOENBERGER FROM GRANT HEILMAN





Houses built directly on the beach, with no dunes for protection from waves, are doomed. A winter storm blasted these exposed houses on Fire Island, N.Y. (center).

At Ocean City, Md., devices erected to halt the natural flow of sand along the shore in order to maintain the beach have wreaked havoc down current. Five miles of beach along pristine Assateague Island have seriously eroded (near right). Some buildings at Ocean City are poised for disaster, and even efforts to replace beach sand won't hold off destruction forever (far right).

The effects of last March's storm—which although powerful was by no measure an oddity—were exacerbated by erosion of the beaches along the New Jersey shore. Beaches normally serve as the mainland's first line of defense because mountainous storm waves expend most of their energy rushing up gradually sloping expanses of sand. But Chief Johnson notes that in parts of Seabright "there's no beach at all. The water is right against the seawall." The wall thus bears the full brunt of storm-lashed waves.

Seabright is not alone in its plight; disappearing beaches threaten hundreds of oceanfront communities. "Seventy to ninety percent of the world's beaches are eroding," says Orrin Pilkey, professor of geology at Duke University. Nearly all the beaches along the Atlantic and Gulf coasts are in retreat. There, many communities have lost their beaches as a direct result of the battle they are waging to avoid being washed away by the sea. Fought on a 2,700-mile-long front stretching from Maine to Texas, the struggle is over the areas known as coastal barriers—thin, ecologically fragile strips of sand that mark the eastern edge of the United States.

Until recently, coastal barrier communities could rest assured that the U.S. government would fight with them, constructing seawalls and other protective devices, providing subsidized flood insurance, and helping to build and rebuild roads, sewers, and water supply lines. But coastal engineers and geologists have found that these efforts are futile and often even harmful, and the federal government has tentatively begun to pull out of the war. State governments are, in many cases, following the federal lead.

The Rising-Tide Blues

Coastal barriers—also called barrier islands—may be true islands, sand spits, or bay barriers that touch land at both ends and create a brackish bay. In their natural state, these barriers typically have a broad beach fronting the ocean backed by dune fields that cover most of the island, with salt marshes behind that. Although they form vital habitats for many waterfowl and more than 80 percent of the fish caught commercially in eastern waters, barriers are most famous for their beaches, which may stretch for miles along the coast. Barriers include such well-known resorts as Miami Beach, Virginia Beach, Atlantic City, and Hilton Head Island, as well as undeveloped wildlands such as Assateague Island off Virginia and Maryland, parts of the Cape Cod National Seashore, and Cumberland Island off Georgia. These beaches beckon millions of visitors each year who are unknowingly responsible for their destruction.

The problem stems mainly from the fact that sea level is rising—indeed, sea level along the East Coast has risen about a foot in the last century. This phenomenon isn't new; the seas have been rising since glaciers began to melt at the end of the last Ice Age 15,000 years ago. However, many scientists expect the ocean to rise even faster over the next century because of the greenhouse effect. This is the rise in global temperature due to an increase in carbon dioxide, primarily from burning coal, that traps heat in the atmosphere. Some scientists say this effect will speed the melting of the Antarctic ice cap; others expect higher global temperatures to warm surface seawater and cause it to expand.

Whatever the exact mechanism, the U.S. Environmental Protection Agency recently warned that sea level would rise at least 2 feet, and perhaps as much as 10 feet, by the year 2100. Along the East Coast, the slope of the coastal plain is so gentle that a sea-level rise of only 1 foot moves the shoreline inland 100 to 1,500 feet.

As sea level rises, barrier beaches normally move up the continental slope towards the mainland. In this "barrier island retreat," the sea essentially pushes the barrier islands before it like foam floating on a wave. What was once beach is submerged under the ocean, the beach moves back to where the dunes and marshes were, and the salt marshes encroach onto the mainland.

Problems arise when buildings and roads stand in the way of the shifting

PHOTOS: JAMES BALOG; ROBERT PERRON/PHOTO RESEARCHERS

sands. About 40 percent of the barrier beaches are heavily developed, and that percentage is steadily increasing. Between 1945 and 1975, the amount of developed land on the barriers more than doubled, according to a 1979 study by the U.S. Geological Survey (USGS). Furthermore, notes Harry Lins, the hydrogeologist who conducted the study, in the last ten years "there's been a dramatic increase over and above what we found." For example, Virginia Beach is growing by 11,000 permanent residents annually. And Jay Hair, executive vice-president of the National Wildlife Federation, tells of a barrier-island development corporation that recently sold $10.2 million worth of real estate in one day.

If the barrier islands moved at a steady and constant rate, problems would be less traumatic. Beachfront homeowners would simply return each summer expecting to find another chunk of their front yard missing. But the movements of the beaches are more like those of a football team—on some downs they gain many yards, on others they hardly move at all, and on still others they may even travel in the opposite direction.

Storms are the wide receivers of the game—the players who make the occasional spectacular play. Winds whipping across the ocean move a bulge of water topped by huge waves onto the beach. Such a "storm surge" can send a wall of water 25 feet higher than mean sea level crashing over the barrier island. In hours storms can create new beaches, poke holes in existing ones, drown entire islands, and destroy millions of dollars worth of beachfront property.

Dunes play a crucial role in the normal give and take between land and sea, and they act as stabilizers during the more dramatic transfers that may occur during major storms. Large waves may either erode sand from the dunes, carrying some offshore and depositing the rest on the beach, or throw sand from the beach onto the dunes. Later, gentler winds and waves return sand from the dunes and offshore areas to the beach. Dunes also act as natural, albeit imperfect, barriers against flooding. Enormous storms may actually carry sand from the beach and dunes across the island and into the marsh on the other side, a process known as overwash. This sand forms a base for more dune formation as the island retreats.

The hero of the dune fields is beach grass. Grass that is buried by sand grows up through the new layer, holding it in place and stabilizing the dunes. Grass that is uprooted by storms may be thrown onto a beach miles away, where it can take root and start a new dune. Tough as it is, though, dune grass is easily destroyed when stepped on or run over by people and vehicles—a major concern on many beaches.

And when the beaches are developed, "the first thing some people want to do is to bulldoze down the dunes so they can see over them," says Tom Bruha, chief of shore protection for the U.S. Army Corps of Engineers in New England. "If they understood the function of the dunes, I think there would be a different attitude toward bulldozing anything on the beach." Without the protection of the dunes, owners of beach homes often find storm waves nibbling at their foundations. The cry then goes out for "shoreline protection" measures.

Tumbling Walls

Building massive seawalls, such as the one in Seabright, is one possible tactic. But while the walls work—at least temporarily—they almost inevitably result in destruction of the beach in front of them. Blocked from expending their energy in rushing across the beach and into the dunes, storm waves bounce off the seawall and carry the beach away instead. "The more energy that comes in, the more sand moves," according to Paul Jeffrey Godfrey, associate professor of botany at the University of Massachusetts-Amherst and a regional leader for the Interior Department's Coastal Barrier Study Group. "Away it goes, out into deep water. The walls eventually fail because they are undermined and fall over." Meanwhile, be-

DENNIS RAULIN/BRUCE COLEMAN, INC.; MARK BENEDICT

Winds move a bulge of water topped by huge waves onto barrier beaches during heavy storms. At Coast Guard beach on Cape Cod National Seashore, workers built a tall sand dune to help protect this bathhouse (left). But to no avail: dune, bathhouse, and parking lot all washed away in hours during a major 1978 winter storm (right).

hind the supposed safety of the seawall, development may have proceeded apace.

Groins are also commonly used to protect shorelines. They are short, squat structures, often resembling rocky piers, that jut out into the ocean and capture passing sand from the long-shore current. This current, induced by waves approaching the shoreline at an angle, causes a net flow of sand in one direction along the beach. The groins—usually found in social groups known as groin fields—interrupt the long-shore current, building a wider beach just above the groin but rapidly eroding the beach down current. "If you trap sand one place and hold it, then you're going to have less of it somewhere else," says Douglas Inman, director of the Center for Coastal Studies at the Scripps Institution of Oceanography.

Beach nourishment, or replenishment, is a less disruptive strategy. The idea is simply to add sand to what is already there by trucking it in from the mainland or dredging it up offshore. Beach-nourishment projects don't try to prevent the movement of the sand, don't ruin the beach for recreation, and don't cause problems for neighbors. Naturally, there's a catch.

"Beach nourishment is not a final solution," says Norbert Psuty, director of the Center for Coastal and Environmental Studies at Rutgers University. Since the processes that were removing sand in the first place continue to occur, erosion proceeds as it did before the project. If the sand used for the nourishment project is too fine or placed improperly, erosion may even proceed more rapidly. In any case, notes Psuty, "A few years down the road you're going to have to do it again, and again, and again."

A recent Corps of Engineers project to restore the beach to Miami Beach cost about $65 million—for less than 15 miles of coast. However, the restoration did bring in over $200 million in revenues from added tourism in its first year, according to Psuty, and much of this revenue is returned to the government in the form of taxes. However, few communities can expect the kind of economic benefits that persuaded the Corps to sink money into Miami Beach. For ordinary communities, the choice in the short run may be between funding beach nourishment privately and losing the beach. But in the long run, beach nourishment is doomed to fail. "Even wealthy communities can't keep it up forever," states Duke's Pilkey.

At the Cities on the Beach Conference, held in January at Virginia Beach to discuss the dilemma of barrier beaches, Pilkey laid out his view of what must happen. "You can have beaches or you can have buildings on barrier islands, but you can't have both," he said. Since the beaches, not the buildings, are what attract people to the shore, he argued that coastal communities and federal and state government should begin planning now to gradually abandon the buildings. With a twist of cynicism, he did note that such an abandonment "would require owners on the front lines to be good sports about it."

Other scientists and engineers are adding support to Pilkey's call. "The best and most appropriate uses for the coastal barriers," says Paul Godfrey, "are recreation, nature studies, science, natural resources, fishing, swimming, and sailing—but not permanent habitation. The development patterns that have been going on in the last ten years have been madness."

Lieutenant Colonel Ronald G. Kelsey, assistant director of civil works and environmental programs for the Corps of Engineers, addressed the issue in similar terms at the barrier-island conference. While arguing that shoreline erosion-control measures can work, he noted that successful projects are both "very expensive and very complex." Thus, he also thinks that the United States faces a fundamental choice: "Considering that the physical resource is in fact finite, we're either going to find a better way to use the coast or go from one headache to another."

Residents of the barriers often consider attitudes such as Pilkey's inherently unfair. "You've lived here 20-odd years and someone's telling you to give up your home and land," laments Angie Machiros, a selectman in Newbury, Mass., and a long-time resident of Plum Island, which lies just off the coast. "There has to be a happy balance between the fragile environment and the human population."

Jim Scott, executive director of the Coastal Properties Institute, an association of coastal builders committed to environmentally sensitive development, maintains that not all beachfront development is destructive. He points to that now proceeding on Kiawah Island, S.C., as the "state of the art." There, homes are set well back from the ocean, behind two sets of dune lines. Lagoons behind the island may be drained and then used to channel away floodwaters during a storm. The developer even runs a turtle management program that collects sea turtle eggs from the beach, guards them against predators, and then releases the hatchlings into the ocean. Kiawah Island, Scott maintains, proves "you can do environmentally sensitive coastal development, and people are willing to pay for it." Single-family homes range from $150,000 to $250,000.

Paying the Piper

When storms strike beachfront communities, not only their residents but also taxpayers across the country must pay. In addition to spending federal funds on rebuilding roads, sewers, and bridges, the government runs a subsidized flood insurance program that covers the coastal barriers. "The federal government has spent billions on flood insurance over the last 20 years," says Henry Lins of the USGS. But these expenditures do not allow the government to limit development to relatively safe areas.

In the event of a hurricane, evacuating most developed barrier islands takes more than 18 hours, and often more than 24. But according to Neil Frank, director of the National Hurricane Center (NHC), "I'm just not going to be able to give warnings of 24 hours." The NHC now tries to give 12 hours' warning for evacuations.

PHOTOS: PAUL J. GODFREY; STEPHEN LEATHERMAN

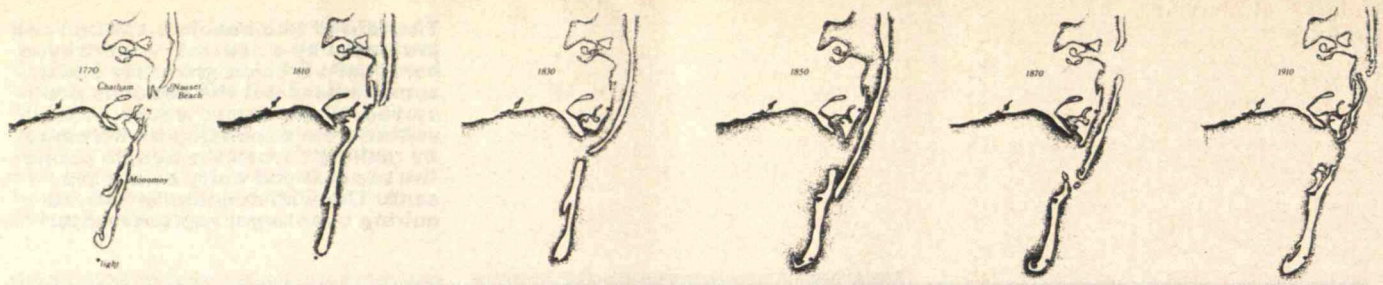
The fate of two beaches, natural and protected by a seawall, is portrayed here. Left: Erosion gradually claims some houses but the beach is preserved. Right: Storm waves, prevented from expending their energy by rushing across the beach, pound the seawall and carry awary the sand. The wall eventually fails, requiring ever-larger replacements.

At the Cities on the Beach Conference, Frank used the case of Hurricane Alicia, which hit Galveston, Tex., on August 18, 1983, to illustrate his point. Twenty-four hours before it hit, the storm was a weak hurricane headed for Corpus Christi. But twelve hours before coming ashore, the storm intensified and turned toward Galveston. By then it was too late to evacuate, so all residents in unprotected areas were moved behind the city's 17-foot-high seawall. As a result, Alicia caused no deaths on Galveston Island but did wreak nearly $700 million worth of property damage.

"Alicia was almost the meteorological disaster we've been afraid of," Frank says. But did it strike fear into the hearts of beachfront homeowners? No. Within a year federal flood insurance funds were being used to rebuild the homes, condominiums, and hotels that had been destroyed. According to Frank, one condo even advertised, "You don't have to live behind the seawall."

New development along the coast increases evacuation times with each passing year, and Frank is scared. "I agree with Orrin Pilkey," he says. "In the long run we have to do something about the way we live along our shoreline. But I'm also

DRAWINGS: MARILYN CATHCART



worried simply about this summer."

With the passage of the Coastal Barrier Resources Act (CBRA) in 1982, the U.S. government entered the debate over what should be done with the barriers. The act forbids nearly all federal expenditures on designated undeveloped barriers. Developed barriers remain eligible for federal aid. "The intent of the act is to get the federal government out of the business of encouraging barrier-beach development," explains Frank McGilvrey of the U.S. Fish and Wildlife Service, who is in charge of coordinating the efforts of various government agencies affected by the act. He hopes CBRA will also serve to "publicize the fact that the government thinks that barrier beaches are dangerous places to live."

Senator John Chafee (R-R.I.), one of CBRA's sponsors, estimates that the act will save the federal government $200 million to $500 million per year and also prevent some undeveloped barriers from being cut up into lots. The bill places no restrictions on what landowners may do with their property, says Chafee, but "they do it at their own financial risk, not at the risk of the federal government."

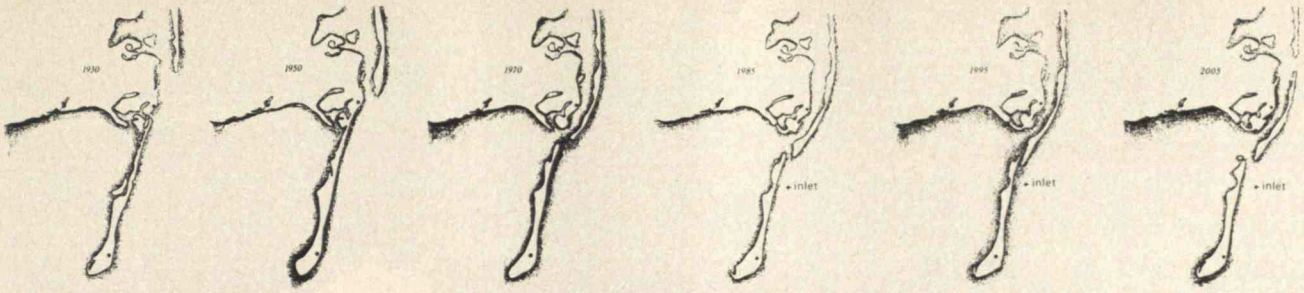
It is not yet clear what the full effect of CBRA will be. McGilvrey believes that the act is accomplishing its objectives in some locations, but notes that "some areas that already had infrastructure, particularly bridge and road access, are being developed privately even though parts of them are in the Coastal Barrier Resources system." The failure of the bill to halt such private development is leading many people to revive calls for government acquisition of the undeveloped barriers; a bill to this effect was introduced during the Carter administration.

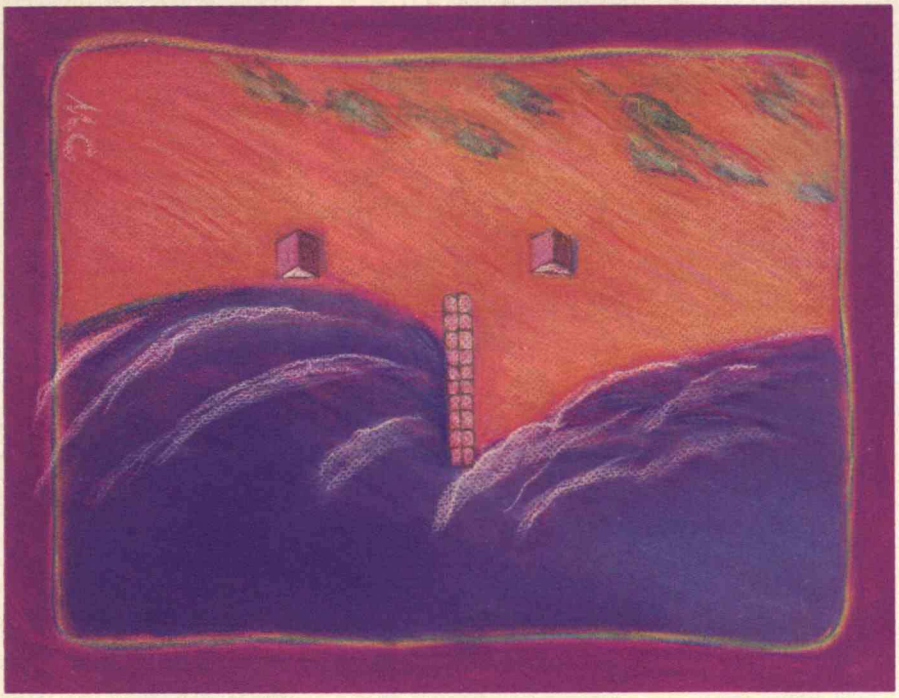
However, according to Robert Hurley, staff member for the Senate Committee on Environment and Public Works, "That was clearly pie-in-the-sky and never would have passed." Even CBRA, which is relatively modest in its reach and had the support of former Interior Secretary James Watt, faced the threat of filibuster from nine senators. Several barrier islands were ultimately excluded from the bill to gain passage, reducing the length of shoreline included from 721 miles to 656 miles. "There was a fair amount of midnight line drawing," says David Godschalk, professor of city and regional planning at the University of North Carolina.

Congress also included a requirement that the Interior Department study the effects and shortcomings of CBRA and report back within three years. A draft report is expected soon, and McGilvrey says it will point out some gaping loopholes. These include several important categories of federal aid that remain available to landowners under the jurisdiction of CBRA—disaster relief, and deductions for casualty loss and mortgage payments on income taxes. Casualty-loss deductions may be the most significant, since they in effect provide partial insurance for beachfront properties. "Because the law allows casualty losses to be claimed on tax returns, people are willing to take the risk," McGilvery explains, "particularly if they have some money."

However, political factors may prevent these loopholes from being closed. If the bill is brought up for amendment, there will be "a lot of pressure to take areas out of the system so that they can get back on the federal dole," says McGilvrey. Thus, proponents have an incentive to stick with the gains won so far rather than trying to strengthen CBRA. Furthermore, Hurley says any provisions dealing with the tax code would have to go through the Senate Finance Committee, which is not favorably inclined toward the bill.

Developers claim that the bill discriminates against landowners on the barrier





Like foam floating on a wave, barrier islands are constantly on the move. Nauset Beach and Monomoy Island, near Boston, have been monitored for two centuries, providing a basis for predicting future changes in their shape (above).

One way barriers move is by "overwash." Storms may carry sand across the island and into the marsh on the other side. This sets the stage for more dune formation as the island retreats (far left).

People building on beaches often destroy the protective dunes and then turn to "shoreline protection" measures such as groins. These squat structures jut out into the ocean to capture passing sand. The beach builds up above the groin but erodes rapidly down current (left).

islands, which is exactly the point that pleases many coastal geologists. "For the first time it recognizes that barrier islands are different from Kansas wheatfields," notes Pilkey. "Two or three hurricanes and a few thousand people dead later, maybe we'll put in something stiffer."

Godschalk says that much of the effectiveness of CBRA will depend on whether state and local governments enact laws supporting the same objectives. Many states are doing just that. One concept that state officials are exploring is called "transfer development rights." The state would allow increased density of development, or provide financial aid, for contractors who agree to build on the mainland instead of beachfront property. New Jersey is negotiating with one oceanfront community to establish such a program. Some states such as Massachusetts now prohibit the use of any state funds to support barrier-beach development. Maine has banned the building of seawalls on sandy beaches, and North Carolina is expected to do likewise. Florida has enacted a series of laws to control development along its coast. However, other states are resisting this trend, particularly those that still have large quantities of undeveloped land.

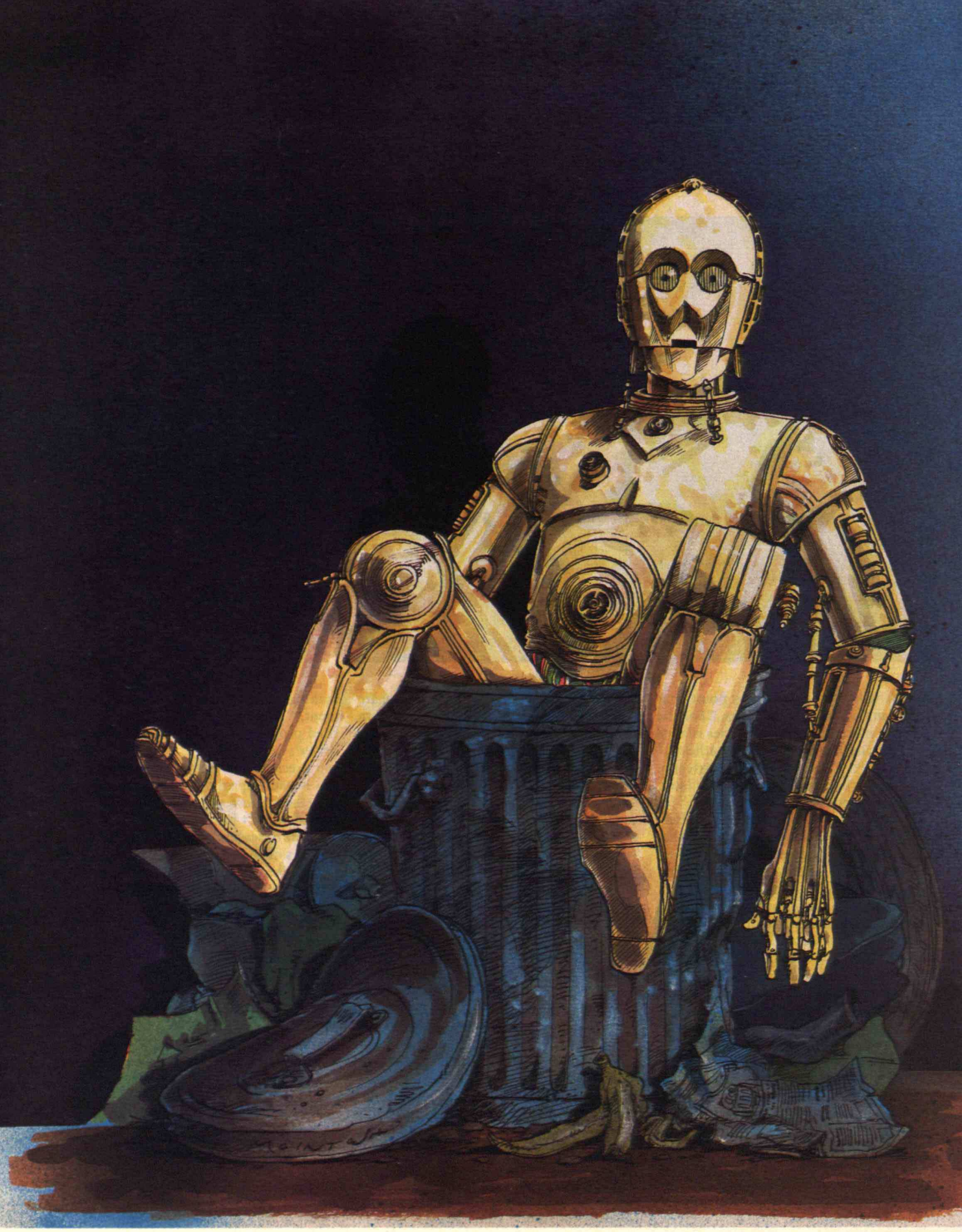
Meanwhile, some coastal geologists are looking at the possibility of working with the natural processes instead of against them. Mantoloking, N.J., has put dunes to work. The community has built up a 19-foot-high dune between homes and the sea, enacted ordinances to prevent the dunes from being disturbed, planted beach grass, and erected raised roads and walkways over the dunes to prevent damage. Paul Godfrey of the University of Massachusetts-Amherst helped to design Mantoloking's dune preservation program. While rising sea level will nonetheless overwhelm the community eventually, Godfrey maintains that the efforts will at least "make it a little later rather than sooner."

Many coastal planners, engineers, and geologists agree that aggressive steps must be taken to free the barriers from development if they are to be saved. "If we build at all, we need to build in a more temporary manner and then leapfrog back when the shoreline erodes," says Douglas Inman of Scripps. "I realize this runs counter to all kinds of thoughts—such as property rights—but people too often don't count on the ocean when they build there." Orrin Pilkey also argues that more segments of society should be involved in making decisions about coastal management. "The individuals who own threatened property should no longer be in the driver's seat," he says. "The shoreline is too precious and the cost to taxpayers is too broadly spread to justify considering only the interests of those who built where they shouldn't have."

These observers recognize that dramatic changes in land-use patterns are not likely to occur without significant public or economic pressure. But with beachfront development in the midst of a profitable boom, the short-term economic picture doesn't look helpful. Similarly, many coastal-barrier residents and vacationers bask in a false sense of security. "There hasn't been a major hurricane on the Atlantic Coast in almost a generation," McGilvrey notes.

But as Godfrey points out, "Just as the sun's going to rise, we're going to have a terrific storm one day. People are lulled into thinking that because we haven't had one in a while, they've gone away—and it's not true." Meanwhile, the beaches and the ocean shuffle restlessly, and wait.

FRANK LOWENSTEIN is assistant editor of Oceanus *magazine, published by Woods Hole Oceanographic Institution.*



ILLUSTRATIONS: JON McINTOSH

Who Said Robots Should Work Like People?

BY WARREN P. SEERING

In the late 1970s, American manufacturers suddenly awoke to the fact that their preeminent position in the global marketplace was being threatened by what they perceived as "cheap foreign labor." That perception, as it turned out, was simplistic. Yet it precipitated a quest for short-term solutions that quickly focused on the fledgling technology of robotics. Many manufacturers believed that the United States could simply build an army of robots with humanoid features that would work in factories day and night, undercutting the advantages of cheap labor abroad. These robots, most people thought, would have manipulators that swung like human arms, grippers that grasped objects like human fingers, and sensing abilities comparable with human senses. Made in the image of humans, these robots would soon outperform humans in cost and efficiency.

This strategy hasn't worked. It was fatally flawed because it assumed that humans are optimally designed to perform manufacturing tasks and therefore deserve to be emulated. This is not true. Humans are designed to throw stones, pick berries, and climb trees. The ability to place a bearing on a shaft has played almost no role in the evolutionary process. In fact, one of the biggest limitations manufacturing engineers have faced is the need to design products that could be assembled by humans. After all, humans cannot generate forces nearly as large as those produced by machines. People are also not particularly precise in their movements, nor are they very adept at stopping and starting suddenly. And compared with machines usually found in factories, they are not very fast. Robots modeled after humans share all these inherent weaknesses.

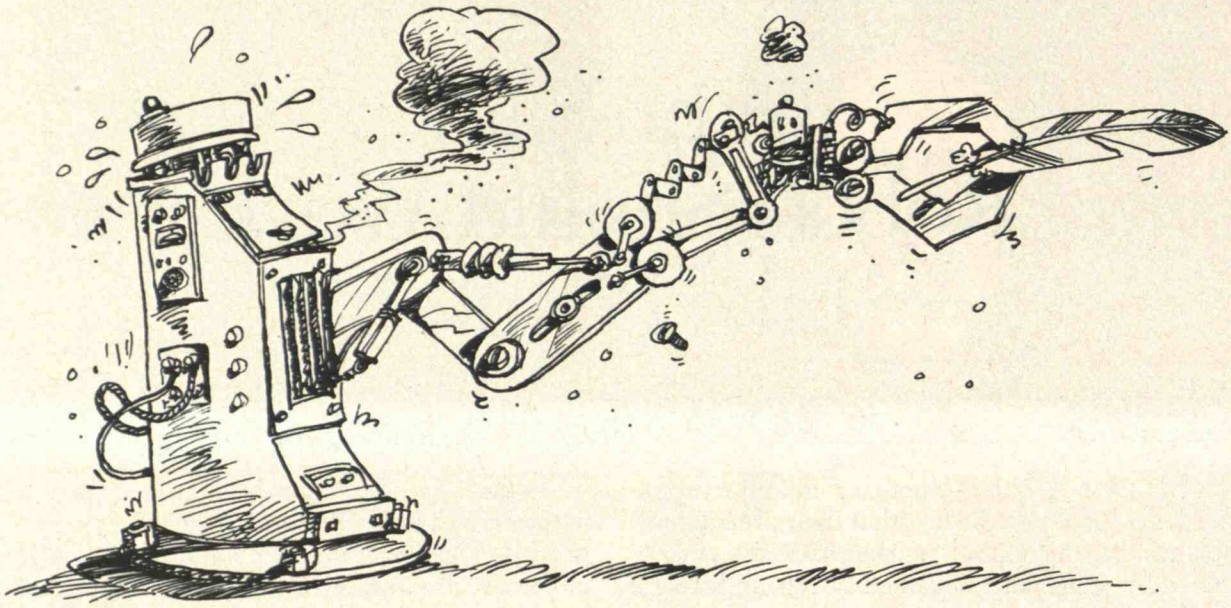
Suppose, for instance, the task of sewing shirts was still being performed by hand, and that you were given the job of automating the process. You would probably not propose that the task be performed by a robot using a needle exactly the way a human does. It has been known for years that a sewing machine, a specialized, high-speed machine under the direction of a human, is a much better solution precisely because it is capable of performing the task in a way that a human alone cannot.

Humans are good at performing certain manufacturing tasks because their intellectual problem-solving skills have allowed them to overcome their physical limitations and perform assembly-line work with reasonable cost-effectiveness. Human workers can correct for mistakes as they go: if the part doesn't go in exactly the way they want it to the first time, they will push and prod until it does go in.

Machines aren't even remotely comparable in

To stay competitive,
U.S. manufacturers must redesign
their products to be assembled by robots
that act like machines,
not humans.

Robots that use finger-like grippers to grasp objects are needlessly complex.



their ability to feel what they're doing or adjust for mistakes. Researchers throughout the country are working to install sophisticated touch-sensing skills, binocular vision, and even reasoning capabilities in machines. This research will very likely produce useful results for the factory of the future. But to the extent that it is tied to the concept of a humanoid robot, such research has little value in helping us cope with our immediate productivity problems.

Even if today's robots could assemble parts as rapidly as a human (and I've yet to encounter a humanoid robot with a fingerlike gripper that comes close), it would still not be a cost-effective alternative to "cheap foreign labor." A typical robot may cost around $50,000. Because the parts it is to assemble must be very accurately located for the robot to use them, the hardware necessary to create a workspace around the robot costs another $50,000 to $100,000. In addition, there are the costs of programming the robot to perform specific tasks as well as the costs of setup, operation, maintenance, and repair. In contrast, laborers in the Far East earn $5,000 a year or less, including benefits. Under these circumstances, a robot would be worn out long before it has paid for itself.

If U.S. manufacturers want to stay competitive abroad, they will have to shift course. They must begin redesigning their products to be assembled by robots that act like machines and not like humans. This will not be an easy task. It will require the wholesale reconfiguring of American products to be assembled by machines that can perform specific and relatively simple tasks. The Japanese are already far ahead in this endeavor. Many of their hottest-selling consumer products have been designed from scratch to be assembled by simple, more limited robots.

Enhanced productivity will not be the only benefit of this new approach to automation; there's also a strong likelihood that factories of the future will produce higher-quality products. The workforce may be profoundly affected as well. While I do not foresee a dramatic drop in the number of blue-collar jobs—machines, after all, require maintenance, repair, and some supervision—we may see a significant reduction in the number of white-collar jobs.

The Evolution of Robots

As a field of basic research, robotics is not new. The concept of humanoid machines performing manual tasks has intrigued innovators for hundreds of years. But only in the last two decades has technology allowed inventors to go beyond simple, mechanistic robots. During the late 1960s, researchers at the Stanford Research Institute (now SRI International) developed an experimental robot called SHAKEY that was unique in its ability to both explore and manipulate the environment. It was capable of locating blocks using a television camera and then arranging them into prespecified arrays or stacks. SHAKEY was not noteworthy in its use of new mechanical technology. But it did lead to new methods for programming computers to direct machines.

In 1972, Victor Scheinman, a researcher working

in the M.I.T. Artificial Intelligence Laboratory, conceived the design for a small D.C.-motor-driven robot dubbed the M.I.T. arm. Other members of the computer science and artificial-intelligence communities also focused on creating software programs to direct robotic machines in performing dextrous tasks. Their aim was to create devices as humanlike as possible, often with the intent of trying to understand how the human mind and body work.

In 1976 the management of General Motors, aware of the need to further automate its assembly lines, initiated a search for a programmable machine to perform light assembly tasks. This search, though it took place only nine years ago, preceded what has become known as the "robot revolution." At that time very few U.S. companies had both the interest and the resources to develop such a machine. So G.M. negotiated an agreement under which Scheinman agreed to enlarge his M.I.T. arm and produce two new prototypes. These were called "programmable universal manipulators for assembly," or PUMAS.

Designed with the human arm in mind, the PUMA has six independent controllable motions, commonly called degrees of freedom. A blender, for instance, has one degree of freedom; it can spin in only one direction. The PUMA can rotate at its base, its "shoulder," and its "elbow," and in three independent directions at its wrist.

These six degrees of freedom give the PUMA flexibility in movement—but at a cost. When all six joints are linked together end to end, or serially, inaccuracies in movement become cumulative. This means that small errors in the angular orientation of the base create large errors in position at the tip. Thus, by the time the gripper, or "end effector," moves into action, it cannot manipulate precisely by machinery standards. Furthermore, the more distant joints in the PUMA are limited in their load-bearing capability. This is because the motors that drive the joints at the end of the arm must be relatively small so that the motors closer to the base can carry them. As anthropormorphic robots go, the PUMA is well designed; its limitations are inherent in the mechanical configuration of humanlike arms.

Despite these limitations, hundreds of PUMAS and other comparably configured robots have been manufactured and sold. But only a small fraction of them are being used to perform assembly tasks. To understand why, it is useful to look at a simple task for which the PUMA was tested: that of inserting light bulbs in dashboard assemblies. The robot was programmed to pick up the light bulbs one at a time from pallets where they were carefully arranged. It would then swing quickly to a point near the target socket and slowly push and twist the bulb into place. Because the robot was not capable of sensing that the bulb was sliding into the socket, it performed the task "blind" by following a carefully learned trajectory. The machine operated under the assumption that both the bulb and the socket were positioned exactly where they should be. The robot was forced to move slowly because it could not produce precise motions at high speeds.

An assembly worker, by contrast, performs such a task by grabbing a handful of light bulbs from a

Threatened by competition in the late 1970s, many U.S. manufacturers thought that a workforce of robots with humanoid features could undercut the advantages of cheap foreign labor. The national media, including Time, jumped on the idea and spoke glowingly of the "robot revolution"—at work and at home.

Even if today's robot could assemble parts as rapidly as a human, it would still not be an alternative to "cheap foreign labor."

bin and inserting them in rapid succession with a simple twist of a finger and thumb. As G.M. and others have realized, a person can perform such tasks much faster than a robot.

When G.M. first initiated this experiment, there was little interest in producing robots for assembly in the United States. But the press coverage accompanying the delivery of the PUMAs provoked a groundswell of enthusiasm, and by 1981 more than 150 robot companies had sprung up in the United States. The standard joke at robotics trade shows that year was that more companies were manufacturing robots than buying them. If you discount the robots sold to research laboratories, that was probably true.

There were several reasons for this sudden flurry of activity. To alarmed manufacturing executives, the idea of purchasing robots to replace expensive and uncooperative workers seemed much more appealing than the thought of making fundamental renovations in their antiquated production systems. Furthermore, there were few barriers to entry into the robot market. The mechanical technology in robots was fairly traditional and well-understood, and any good mechanical designer could build one with the help of a computer wizard. In 1980, venture capitalists were eager to fund such operations.

Today all this has changed. Many of the robot companies have folded and venture capitalists are leary of investing in robotics. Even though robots now incorporate technological innovations such as video-camera systems and fingertip sensors, these devices have not significantly enhanced the machines' performance in completing assembly tasks. While much research must be done to determine how to use sensors to improve the capabilities of computer-directed machines, it has become clear that human-like robots will not soon replace humans at manufacturing tasks that require a significant degree of dexterity.

What Robots Do Well

Once we rid ourselves of the notion that robots should be made in our image, we can begin asking the right kinds of questions about how they should be designed. For instance, what tasks are human beings not particularly good at? What kinds of manufacturing tasks are better performed by machines?

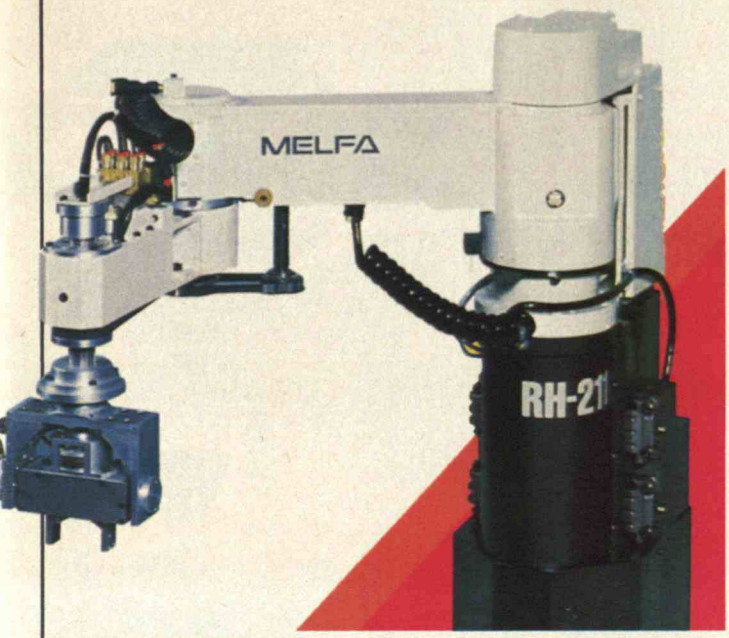
Today robots are commonly used to spray-paint auto bodies and other large surfaces. The machines have been cost effective because a low degree of accuracy is acceptable and low speed is desirable. But the biggest advantage is that robots do not need to breathe. One of the major costs of human-operated spray-painting systems is that of providing adequate ventilation: large volumes of air must be carefully filtered to keep workers from inhaling toxic chemicals and to prevent contaminants from affecting the coating process. Since robots do not require breathable air, outside air flow can be kept to a minimum, improving the finish quality of the paint. Robots are better at this task not because they are faster or cheaper than humans, but because they can work in a place where humans cannot.

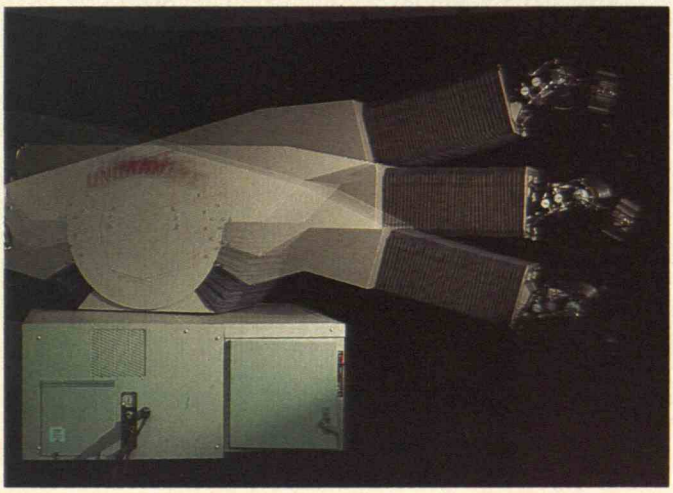
Robots are also often used for spot welding automobiles. To perform this task, the robot does not have to interact in a carefully controlled way with the piece of work. All it need do is anchor the spot-welding tool roughly to a part already lightly welded in place on the car and then apply pressure and electric current. Spot welding has traditionally been performed by skilled laborers working under highly undesirable circumstances. The welding tools can weigh 100 pounds or more, and even though counterbalanced, they are difficult to handle. Because of the limitations of human strength, people perform this task more slowly than robots. Large, hydraulically powered robots are the solution of choice in this case because they can do what humans cannot: produce and control large forces.

A third major area where robots are used effectively is that of installing chips on printed circuit boards. Again, this application has proved cost-effective because of a capability that robots have and people don't: a robot, once properly programmed, will not put a chip in the wrong socket.

Circuit boards generally cannot be tested until all the components—chips, capacitors, inductors—are in place. If the wrong chip has been inserted or a diode put in backward, the board will not function properly and thus will be useless. Locating and fixing such mistakes can be extremely difficult and time consuming. Robots have the advantage in "board stuffing" because the boards they produce have a much greater likelihood of working.

Once manufacturers decide what sorts of tasks they want robots to perform, the next step is to reconfigure products to be assembled by the simplest robots possible. The simpler the machines, the faster





Developed to assemble auto parts for General Motors, the PUMA (above) was one of the first computer-controlled robots designed with the human arm in mind. Its six independent motions, called degrees of freedom, give the PUMA flexibility. However, there is a cost: the robot cannot manipulate objects precisely, and its load-bearing capacity is limited. Although more sophisticated versions of the original PUMA (left) continue to be displayed and sold at robotics trade shows, only a small fraction are used to perform assembly tasks.

The Japanese have designed simpler robots with fewer degrees of freedom. These machines, such as Mitsubishi's new Melfa arm (above, left), are very precise at faster speeds.

and more accurately they perform. Yet in the United States, more limited computer-controlled robots have often been dismissed as beneath the state of the art, because of their inability to perform tasks in humanlike ways. As a result, many U.S. (and European) manufacturers who have decided to automate extensively are buying large numbers of robots from the Japanese, who have once again chosen the right direction.

The Japanese Advantage

The Japanese have developed families of simple robots with limited degrees of freedom for use in their own factories. While U.S. robots are usually built with six degrees of freedom, the Japanese have deliberately designed robots with fewer joints so they move faster and vibrate less. One of the most popular is the SCARA arm, which has three and in some cases four degrees of freedom. At the same time, the Japanese have designed many of their products to be assembled by the SCARA-type arms and other simple machines. They have also simplified the assembly process to utilize such machines more effectively. For instance, Japanese videocassette recorders, now being snapped up by millions of American consumers, are assembled by rows of simple robotic machines, each designed to fit into a preplanned process of production. Furthermore, the mechanical components inside a Japanese videocassette recorder can all be assembled from a single (usually vertical) direction. Not only is this "Z stack" assembly more efficient, but gravity acts to stabilize the parts during the insertion process. Many U.S. products, in contrast, are designed so that the components must be inserted sideways as well as vertically, making the transition to simpler robots far more difficult.

The mechanical ability of the simple Japanese ma-

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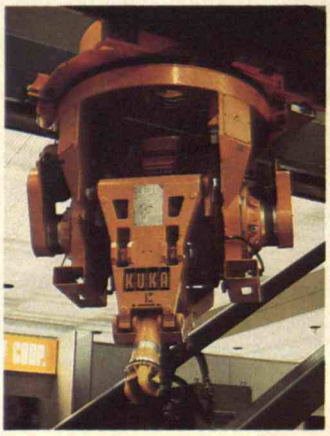
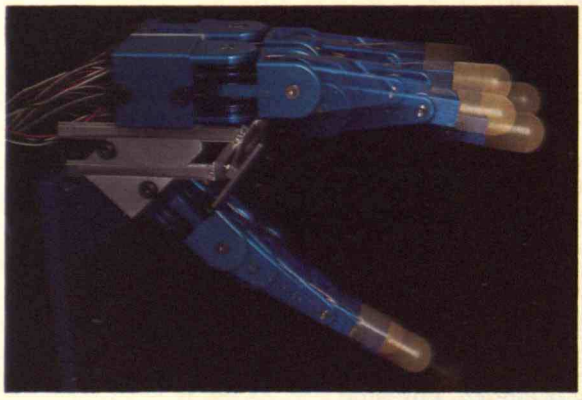
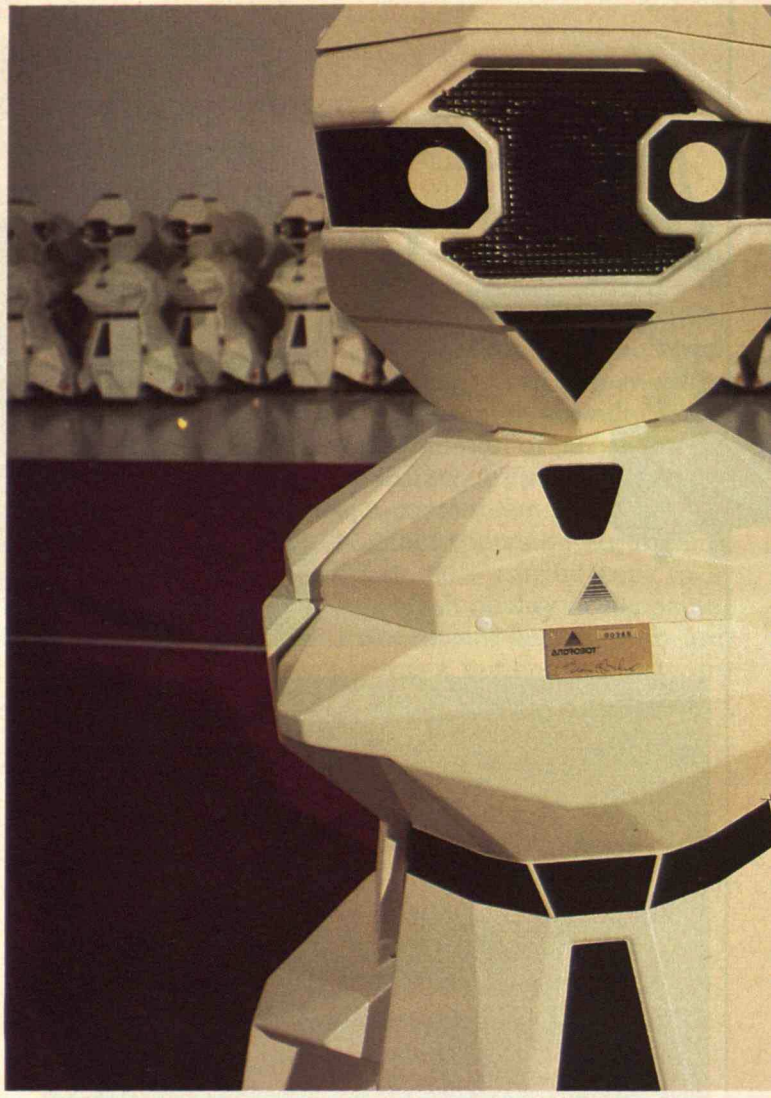






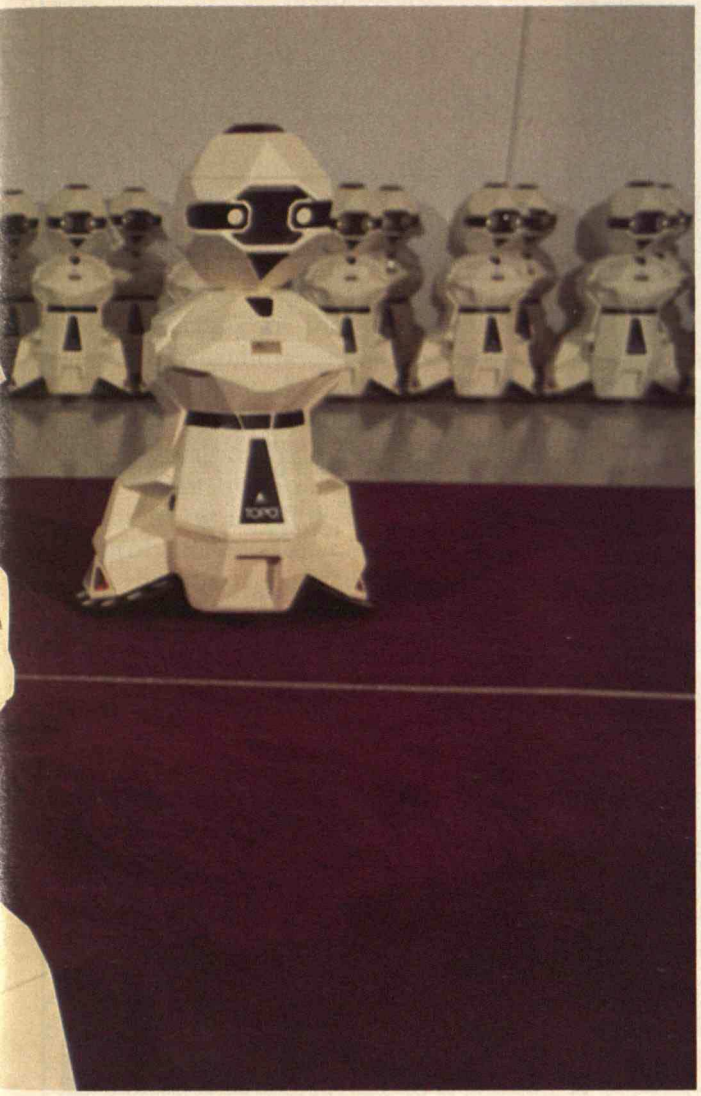
chines is limited. But they have one big advantage: they can easily be reprogrammed to manufacture a slightly different model of whatever product they're assembling. And that capability has paved the way for a very successful marketing strategy — illustrated by the story of Sony's Walkman.

Even when the first version of the Walkman was selling well, Sony introduced a new model, effectively going into competition with itself. As model two was capturing a share of the market, the company introduced model three. Several subsequent models have been introduced, each successful. Challenging one's own market share defies conventional wisdom: Sony would have made much more money on the first model had the company held off with the introduction of later models. However, Sony believes that it can best stay ahead of the competition by continually offering improved products—a wonderfully aggressive posture.

Sony has been able to produce successive versions of the Walkman without making major investments in new capital equipment by depending on robots of limited flexibility. However, these facilities alone are not enough. To create ever-better designs, Sony has had to employ large staffs of highly skilled engineers and technicians. This has been possible because Japan has roughly four times as many engineers and technicians as does the United States, even though Japan's population is about half the size of ours. More than any other single factor, the availability of engineering talent has allowed the Japanese to bring products to market quickly, and maintain a technological edge in making various consumer products.

Following the Japanese lead, the factory of the future will be based on simple, computer-controlled machines. And such machines will be smaller, faster, more precise, and less expensive than existing robots. For instance, today's robots have been designed to reach for parts and then assemble them, much as

PHOTOGRAPHS: WARREN SEERING; DAN McCOY/RAINBOW



The huge arc-welding robot at far left, top, is typical of many machines that are designed as "solutions" before the problems are considered. This German robot weighs several tons, yet it needs to lift only a five-pound welding tool.

Millions of dollars are being spent on developing fingerlike grippers with sophisticated touch-sensing skills (far left, bottom). But machines to which tools can be directly attached are far more accurate than those with grippers.

Many Americans envision a time when an army of humanlike robots will work day and night in factories (left) and serve as newspaper fetchers at home (right). In reality, the factory of the future will be based on simpler, faster machines, and newspapers will be delivered via electronic mail.

people do. To reach a large number of parts, robots must have long arms, and the longer the arms, the less precise the motion. In the future, assembly robots will not need such long arms because they will not be expected to reach for parts; inexpensive conveying mechanisms and other devices will deliver parts to them. The assembly robots will then be free to spend all their time actually assembling products.

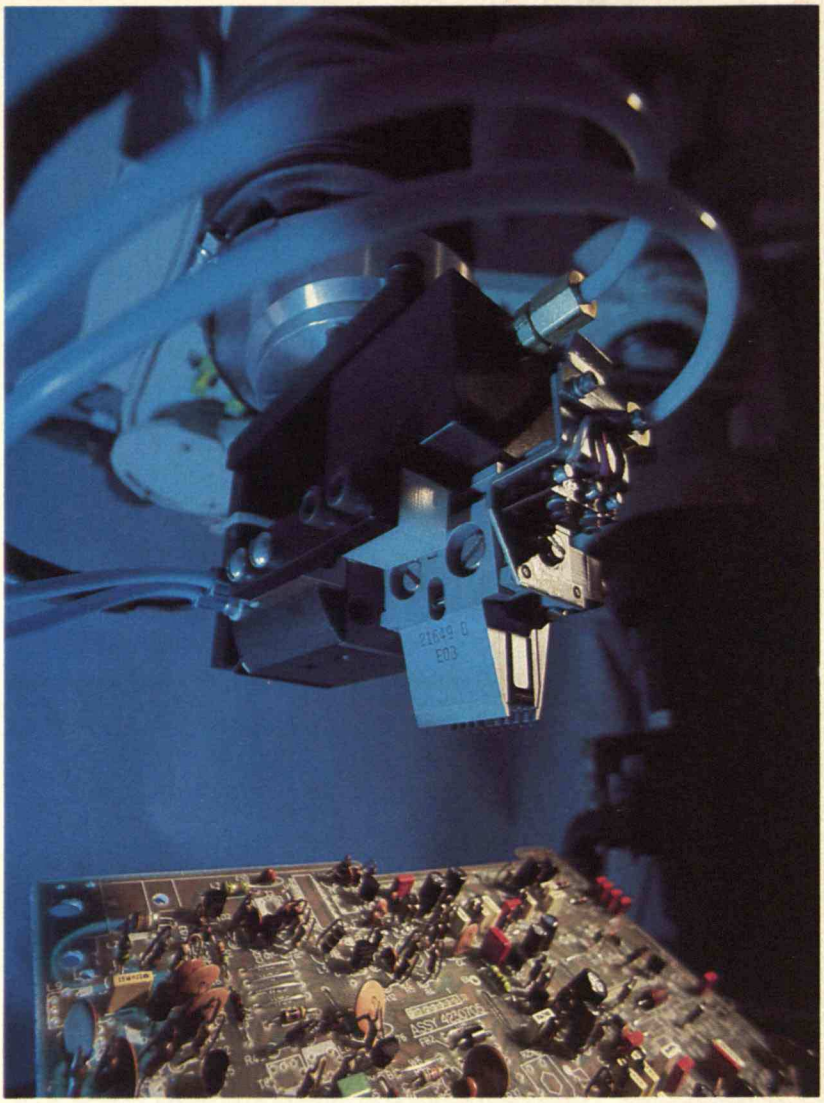
In building the next generation of robots, engineers will design end effectors not as grippers but as tools. A robot that uses a gripper to hold a tool is needlessly complex. Humans are limited to operating in this way, but machines are not. Machines to which tools can be directly attached can position them much more accurately than machines that hold the tools by a gripping mechanism.

The workspace around the robot will also change significantly. The concept of robots as mechanical humans has prompted engineers to design robots to recognize when a person enters their workspace, and to react accordingly. The implication has been that humans and robots are coworkers. As a result, robots have been built to operate slowly and move as humans do to minimize the danger of a mishap.

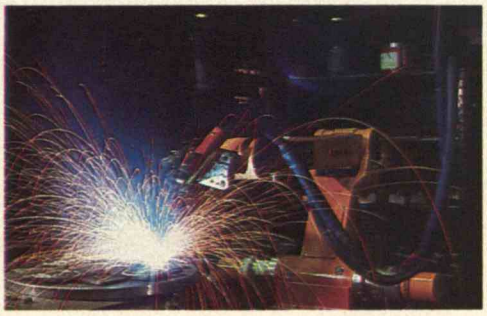
If robots were treated as the machines they are, this approach could be abandoned, yielding significant savings in production costs. We cannot afford to build robots that operate so slowly that they can accommodate the presence of people in their workspace. After all, few people perceive an arbor press or a packaging machine as a coworker. And no one would expect a computer-controlled lathe to stop cutting just because someone touched the spindle. People have no business touching the spindle. Similarly, there is no reason for people to be within the bounds of a robot workspace. Once we recognize that robots are machines, we will begin to build them like machines: fast, reliable, and simple to operate.

Most of the work on robot sensors has centered on vision and touch, probably because designers

PHOTOGRAPH: HANK MORGAN/RAINBOW



Robots are better than humans at a number of manufacturing tasks. For instance, when "stuffing" printed circuit boards, robots—unlike humans—will not put a chip into the wrong socket (left). Robots are also effective in spot welding parts onto automobiles because they can do what humans cannot: produce and control large forces (bottom).



have perceived these as the two most important senses for humans performing assembly work. But robots are not destined to perform assembly in ways that humans do. To be most effective, robot technology will increasingly employ information available from acoustic sensors, pressure sensors, thermal sensors, magnetic sensors, and acceleration sensors, as well as from vision and touch sensors. In some assembly lines, for instance, parts could be correctly fitted using acoustic sensors; if the parts are not joined accurately, the sound patterns they emit will be disrupted.

Lower Inventory, Higher Quality

As robots become more reliable, factory performance will become more predictable. Such predictability promises significant cost savings. While assembly costs account for 5 to 10 percent of the price of making a typical product, the cost of maintaining an inventory of parts for this product may be as high as 20 percent. Such an inventory has traditionally provided a buffer against uncertainty. But with predictability comes the ability to determine in advance how many parts of each type will be needed during any given period. With this knowledge, manufacturers can minimize their inventories, requiring instead that suppliers deliver only the number of parts that will be needed. This approach, commonly called "just-in-time delivery," is well established in Japan and is becoming more widespread in the United States.

In addition to reducing inventory, just-in-time delivery has other advantages. Since the number of parts available is the number needed, bad parts are immediately detected and rejected. At present, assembly workers occasionally "hide" their mistakes in inventory. Since many workers have a daily quota, they have an incentive to use bad parts to meet that quota; it's faster than waiting for good parts. Since defective products are then shipped to another area of the factory or to another plant, where they sit in

PHOTOGRAPHS: DAN McCOY/RAINBOW; BILL PIERCE/RAINBOW

Once robots create order in the factory, computers may replace white-collar workers.

inventory until needed, it is unlikely that someone will track them back to the team responsible for the defects. Because of the large quantity of defective items that must be rejected, U.S. consumers pay more for goods. They also sometimes receive "lemons" that make it through quality control.

At Toyota, internal-combustion engines are made in one plant at the same time that corresponding cars are being assembled in another. This means that if a problem develops in the engine-production facility, there is tremendous pressure to discover the cause and fix it. The result is higher-quality products.

The Last of the Paper Pushers

Much has been made of the fact that blue-collar jobs may be lost when robots are introduced. Yet U.S. labor unions have generally supported the use of advanced automation. The unions are well aware that job security for blue-collar workers will depend upon U.S. industries' ability to stay at the leading edge of technology. According to some projections, as many as 10,000 robots may be in place in the automobile industry by 1990. Yet the number of people who may lose their jobs as a result must be compared with the hundreds of thousands of workers who have been laid off in recent years because of the industry's failure to remain competitive.

The situation is quite different for white-collar workers. As automation takes the guesswork out of manufacturing, computers can more easily perform tasks previously assigned to people. These tasks include ordering the required number of parts and tracking the flow of parts and finished products. The more knowledge one has, the less judgment one needs, and in time computerized expert systems may even be able to make many of the decisions now being made by corporate vice-presidents. Thus, the biggest contribution of robots in the factory of the future will be to create an order that permits computers to take the place of white-collar workers.

Once such order is created, all factory jobs that involve gathering and upgrading information become vulnerable. Roger Smith, chairman of the board of General Motors, recently announced the establishment of Saturn Corp.—the first new automobile manufacturer to become part of G.M. since Pontiac in 1926. Smith claimed that the new company will thoroughly computerize its manufacturing and sales operations. The plan, he said, is to "run the corporation without paperwork." He added, "Maybe we won't even need a mail boy."

Saturn Corp. will have to be highly structured and well-ordered to live up to Smith's expectations. This kind of operation will be extremely difficult to achieve because of the number of fundamental changes required, from the shop floor to the executive suite. However, if such a goal can be achieved, it will be much easier to automate the jobs of accountants and purchasing agents than those of the maintenance crew. And such computerization could yield significant cost savings. While a blue-collar worker may earn as much as $30,000 a year, white-collar workers can cost companies $80,000 or more when benefits are included.

Much attention has focused on the robot in the evolution of automated manufacturing. However, its role has been and will continue to be relatively small. The key player in the "automation revolution" is the computer. The use of the computer in factory automation is an area rich with potential for growth and development. But exploiting these possibilities will take time. Meanwhile, we must recognize that there are no short-term solutions to our current problems in productivity growth. We cannot afford to mislead ourselves with the notion that engineers in other countries are less creative or otherwise less capable than ours. Nor should we focus our attention on any one competing nation. In 1982, the French, the Dutch, the Germans, the Italians, the Belgians, the Japanese, and the Swedes had greater rates of productivity growth than the United States.

For the short term, we will remain in a solid competitive position. But we won't maintain that position for long unless we embark on a major long-term, and costly program of reindustrialization. Such an undertaking will entail a complete rethinking of the way we manufacture products and use robotic machines. Reindustrialization will depend heavily on astute application of computer technologies and on the wholesale reconfiguring of parts to be manufactured on the assembly line. Unfortunately, our current strength makes it all the more difficult for us to begin such a massive project. But we must. The competition has left us with no alternative.

WARREN P. SEERING is an associate professor of mechanical engineering at M.I.T. He is currently conducting research on robotic systems in the M.I.T. Artificial Intelligence Laboratory.

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  Professor: Mark S. Wrighton
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  Professor: James Paradis

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  Professor: John S. Carroll

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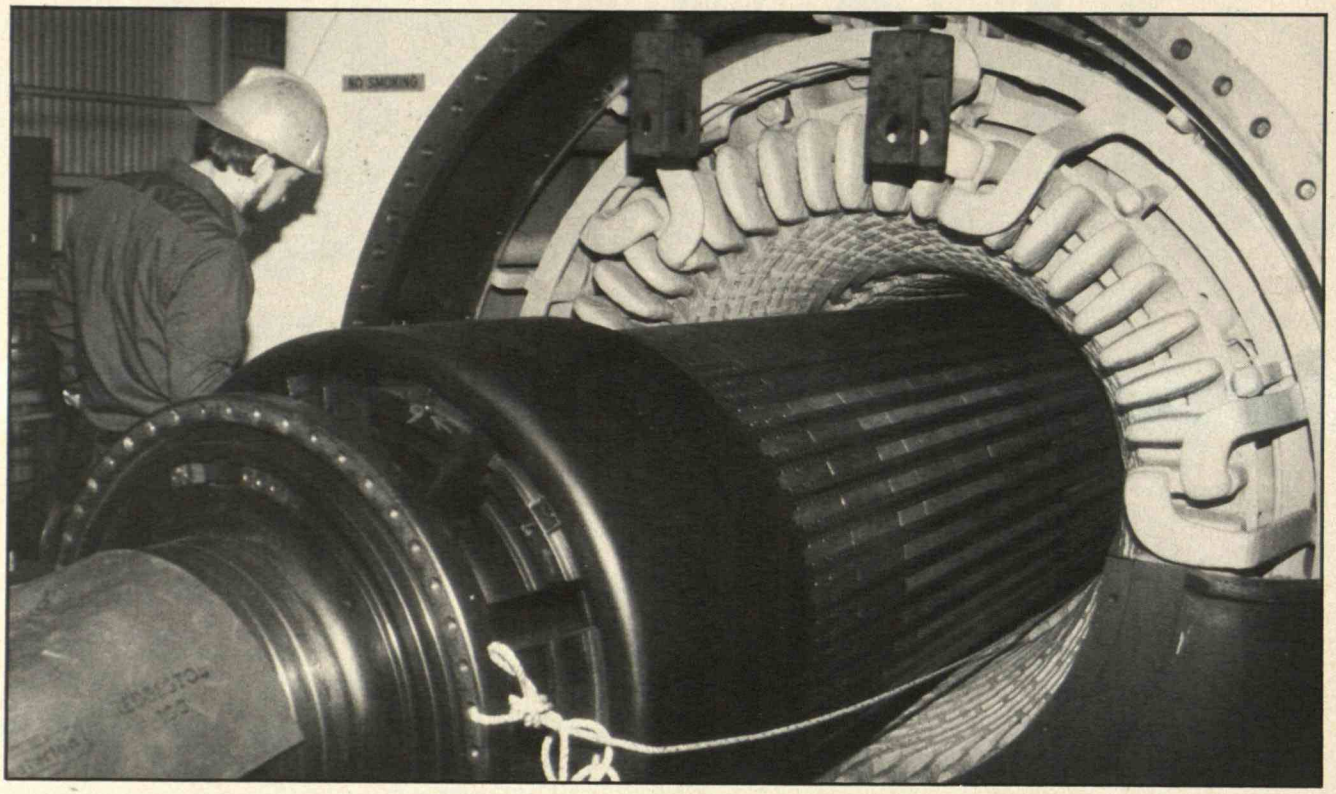


Prolonging the Life of Power Plants

A new technology seems ready to join photovoltaics, wind power, and other alternative means of generating electricity. The newcomer is life extension, a system to increase the working life of fossil-fueled plants by as much as 50 percent beyond their natural two-score years. In January, the Electric Power Research Institute (EPRI), an industry association, signed an agreement with Boston Edison Co. for a $3 million project that will establish guidelines enabling utilites to decide when such an approach is economical.

Like old soldiers, aging power plants don't die; they merely fade away as more economical new plants take over the duties of generating base-load power. Relegated to intermittent peak-load duty, old plants decay as boilers, turbines, generators, and other vital components start to fail. With appropriate maintenance, and sometimes replacement of critical parts, aging plants can generate power as effectively as new plants. This refurbishing technology is well-established; the question is whether the extra power that can be generated justifies the cost of repair.

Until recently, the answer was generally negative—it was cheaper to meet electricity demand by building new plants. But the balance is changing. Because of increased capital costs and interest rates, new plants now cost as much as $1,500 per kilowatt—up tenfold from a quarter of a century ago, when much of the present generation of coal- and oil-fired plants was built. In addition, regulatory problems have significantly lengthened the time between conception and completion of new plants. By contrast, the major capital costs of old plants have been paid, and their operating permits last throughout their lives.

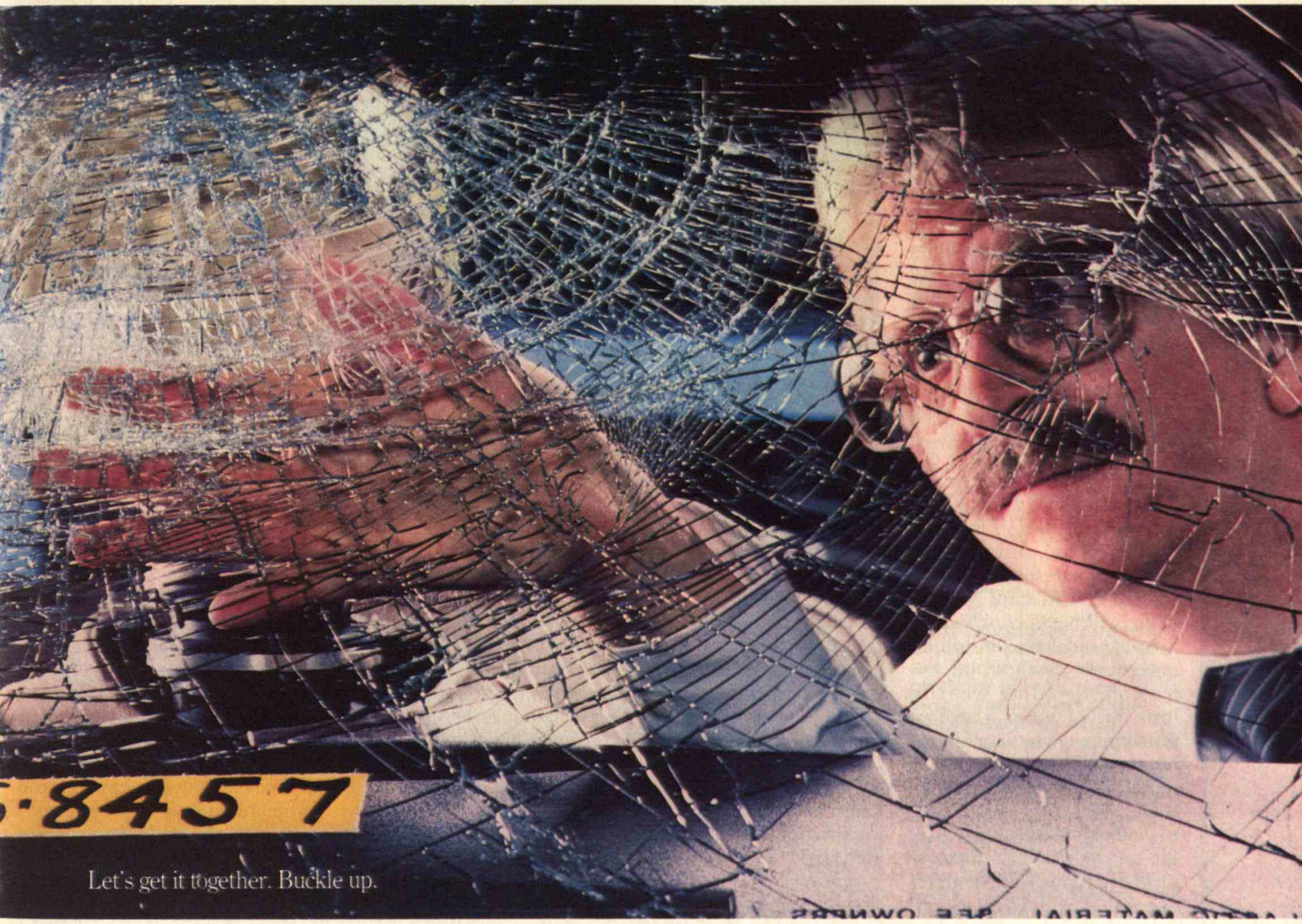
Despite an interval of no growth in electricity demand, industry analysts foresee an increase in the years to come. This potential strain on generating capacity means that life extension will make more and more sense.

The EPRI-Boston Edison project seeks the data that utilities will need to decide whether to extend the life of any particular plant. The key is a series of diagnostic tests designed to reveal signs of metal fatigue, creep, and other conditions that can presage the failure of major power-plant components. Until recently, such tests demanded large samples of metal—a requirement that severely limited the number of

Refurbishing old power plants may provide a "new" source of energy. A battery of tests to determine the condition of major plant components will soon be run at Boston Edison's Mystic power station. The research will produce a set of guidelines to help utilities decide when extending the life of power plants is economical.

PHOTO: BOSTON EDISON CO.

Shattering old ideas about safety.



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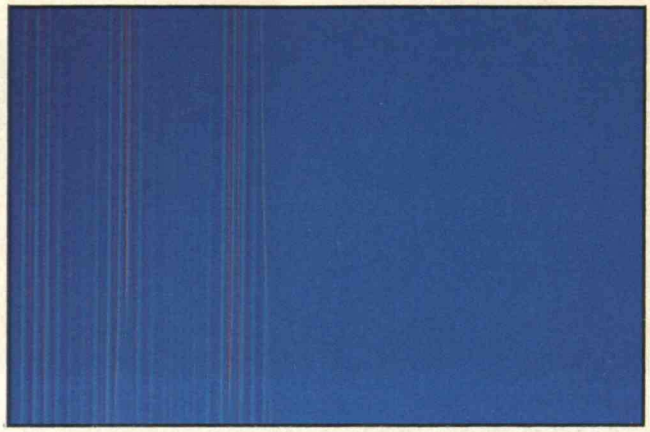
times components could be tested. However, researchers at EPRI and elsewhere have devised a number of nondestructive testing methods. In a "replica technique," engineers wrap plastic film around thick wall piping. Blemishes on the metal surface caused by cracks and other signs of aging transfer to the film and show up under a microscope. Engineers can also monitor the state of turbine blades by running electrical currents across their surfaces. With approaches such as these, technicians can monitor critical parts of a plant whenever they wish.

Researchers will carry out more than 5,000 such tests on a 24-year-old 149,000-kilowatt unit at Boston Edison's Mystic station, just north of Boston. The result, says project manager Richard A. Zimbone, will be "a cookbook—a set of guidelines for utilities on how to go about life extension, detailing what to look at, in what order of priority, and what could prohibit a plant from running for more than 50 years."

Deciding what it will take to extend a plant's life will be the easy part. Once the technical details are settled, utility executives will have to calculate the costs of life extension and combine them with projections for future demand, the cost of building new plants, and other factors such as the cost of capital to determine whether to proceed with the life-extension work. Participants in the new project admit that life extension won't always be justified. But the chance that the technology will add extra years—and megawatt-hours—to the productive lifetimes of some plants makes the joint project an exciting and promising venture.—*Peter Gwynne* □



Super Semiconductor

A few years ago hardly anybody outside the electronics industry knew about gallium arsenide, but now it is in the limelight. Widely used in displays on calculators, digital watches, and toys, this semiconductor is indisputably the best material for many components in microwave and fiber-optic communications equipment. After ending research on Josephson-junction circuits, once considered a promising technology for supercomputers, IBM is now expanding work on ways to increase computing speeds with gallium arsenide. And last year at least two firms—Harris Microwave Semiconductor and Gigabit Logic—began to market digital chips made of gallium arsenide, some of which are to be used for fast computing. Some advocates call this material the "super semiconductor."

That is quite a claim. Despite its research, IBM isn't betting that gallium arsenide will replace silicon—certainly not any time soon—as the workhorse of the electronics industry. Silicon is especially well suited for general applications, such as in personal computers and automobiles, because it is simple, easy to purify, and rugged. "The gods have blessed silicon because of where it stands in the periodic table of elements," says Harry C. Gatos, professor of materials science and engineering at M.I.T. But while the role of gallium arsenide may be limited, a few important computing applications for it are already emerging.

Promises and Problems

There is no dispute that microelectronic components made of gallium arsenide have greater speed than those made of silicon. Gallium arsenide is already 5 to 10 times faster and may someday be 100 times faster, says Gatos. Also, since gallium-arsenide chips require only a tenth the power of silicon chips and can withstand greater heat, they can be packed more closely, a factor that allows further increases in speed.

Speed is of special importance in supercomputers, which are designed to do the most complex computations, requiring many operations and large memories. Supercomputers are typically used to forecast the weather, simulate the performance of aircraft during design, and create animation. In some applications such as radar systems, gallium arsenide's speed will enable a level of performance that would be impossible with silicon, says Gatos. The slower semiconductor simply could not resolve the same numerous, high-frequency signals.

The catch lies in manufacturing gallium arsenide. To begin with, occupational-health physicians are concerned about the large amounts of arsenic—which is not only a legendary poison but also a carcinogen—required to make gallium-arsenide components.

Even if that weren't a problem, manufacturers would face serious difficulties. To fabricate a silicon chip, technicians grow a layer of oxide on the surface of the crystal as an insulator. They then etch conducting pathways in the oxide. Unfortunately, no one has found a way to grow an insulator on gallium arsenide without destroying its electronic properties. Fortunately, gallium arsenide is available in "semi-insulating" form. Semi-insulators behave much like insulators; ions (typically of silicon, selenium, or sulfur) implanted into the semi-insulator create conducting pathways.

"However, ion implantation is a very complex process," says August Witt, professor of materials science and engineering at M.I.T. "The desired stoichiometry—ratio of elements in the material—is very hard to maintain during processing."

It is also more difficult to grow crystals of a two-element semiconductor such as

gallium arsenide than of a one-element semiconductor such as silicon. Depending on the manufacturing process, the yield of useful material in a gallium-arsenide ingot varies from 0.1 to 3 percent, says Gatos. Commercial silicon ingots probably yield 30 to 50 percent useful material, though the exact figure is an industry secret.

Space Manufacturing

Gravity is what creates problems in forming gallium-arsenide crystals. The heavier, cooler liquid in the "melt"—the molten material from which crystals are grown—falls through the hotter liquid, causing convection currents. "It's like growing crystals in a windstorm," says Russell Ramsland of Microgravity Research Associates (MRA), a firm that plans to manufacture the material. The resulting defects destroy the unique electronic properties of the material.

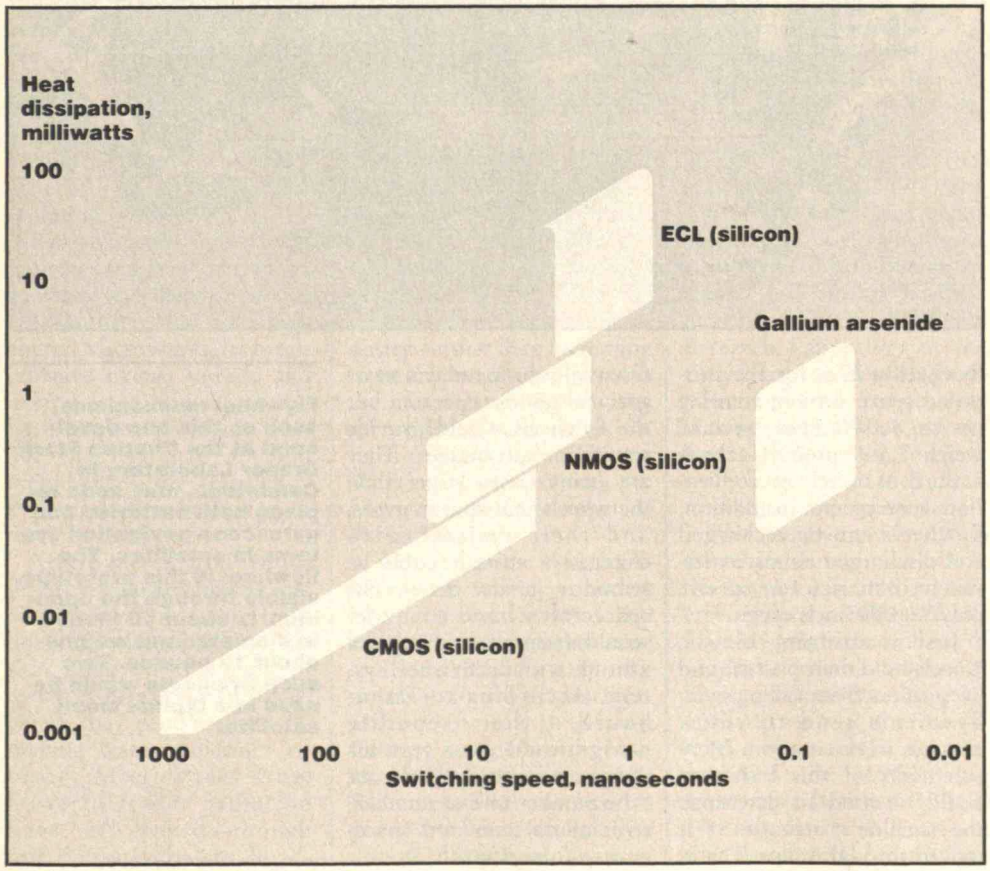
Ramsland says he has the answer: manufacture gallium arsenide in space. There, with almost no gravity, the mixture remains homogeneous. Gatos, an advisor to a joint MRA-NASA project to manufacture gallium arsenide in space, believes yields of good crystal there will be ten times greater than on earth. Space-grown crystals will also have fewer defects. Circuits using them will therefore require fewer redundant components and can be simpler and more powerful. However, for a long time to come, space manufacturing can produce only tens of kilograms of material for critical applications—not tons for broad commercial use.

How Big a Niche?

Despite the limitations of gallium arsenide, Gatos is convinced that it will be useful in the fastest computers. Cray Research, Inc., in the United States and Fujitsu in Japan are working on supercomputers based on gallium-arsenide chips. Anthony Livingston, vice-president for marketing and sales at Gigabit Logic, thinks that within perhaps five years a third of the gallium-arsenide circuits the company makes will be used in computers. He expects the remainder of the market to be in communications, where the circuits are used to translate optical signals into electricity; scientific and technical instruments; and weapons systems. Gallium arsenide will be useful for the military because it is not only faster than silicon but more resistant to heat and radiation.

"How far gallium arsenide will eventually go is a wild guess," says Gatos. "When the transistor first came out, it was considered a curiosity item. But it was a primitive device. In that form it could not amount to anything. The later developments could not have been predicted."

—*Diana ben Aaron* □



Left: Integrated circuits made of gallium arsenide are faster than any type made of silicon. And since gallium arsenide uses relatively little power and produces little heat, chips can be packed closely. (Source: *IEEE Spectrum*)

One problem is that gallium arsenide is extremely difficult to manufacture without defects. Some entrepreneurs hope to grow purer gallium-arsenide crystals in orbit, where gravity is negligible. Other semiconductors such as indium antimonide (opposite) have already been grown in space.

DIAGRAM: OMNIGRAPHICS

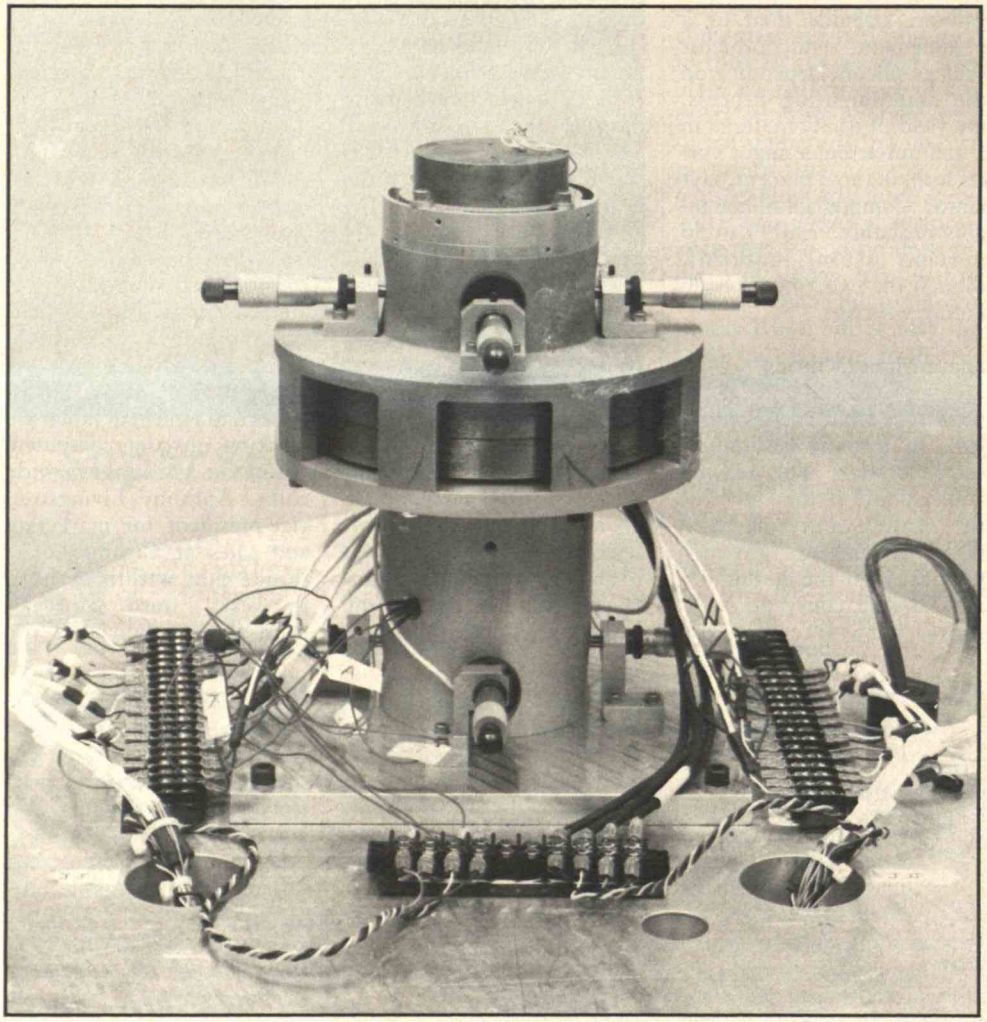
Flying Flywheels

In the weightless emptiness of space, satellites now use gyroscopes to sense and control attitude—orientation with respect to "up" and "down," left and right—and batteries to store electricity. Flywheels, which store energy by spinning at high speeds, may soon perform these functions, according to David Eisenhaure, who heads the CARES (Combined Attitude Reference and Energy Storage) Group at the Charles Stark Draper Laboratory in Cambridge. The flywheels would be suspended magnetically in their enclosure in the satellite to eliminate virtually all friction and wear. They would be simpler, lighter, and smaller than conventional systems, says Eisenhaure—vital goals in the demanding environment of space.

While the spacecraft is in sunlight, the flywheels would be driven to high-speed rotation by electricity from photovoltaic panels. When the spacecraft enters the blackness of space in Earth's shadow, the motor that drives the flywheels would become a generator, converting their momentum into electricity.

Because they are made of high-strength fiber composites—typically boron or graphite epoxy—the flywheels can spin very fast, up to 25,000 rpm. Thus, they can store as much energy as today's batteries but with far less weight. A flywheel system for a satellite might weigh just over 100 pounds; batteries and gyros now carried aloft to perform the same functions weigh 300 pounds. A flywheel system for the proposed space station, rotating up to 8,000 rpm, would weigh 7,500 pounds—about a third as much as conventional equipment. In addition, flywheels can be recharged and discharged almost indefinitely; batteries can survive only 30,000 such cycles.

Just as spinning bicycle wheels hold their posture and keep riders from falling over, flywheels tend to resist changes in orientation. Measurements of this resistence could be used to determine the satellite's attitude as it moved through space. This is essentially how today's navigational gyros operate, but the flywheels would provide significant advantages. They are many times larger than the wheels that spin in gyros, and their resistance to changes in attitude could be sensed in greater detail. The spacecraft's basic computer would measure and control attitude with the flywheel system. According to Eisenhaure, the separate navigational gyro systems that now sense attitude are "the number-one or number-two failure item" on spacecraft.—*John Mattill* □



Flywheel mechanisms, such as this one developed at the Charles Stark Draper Laboratory in Cambridge, may soon replace both batteries and gyroscope navigation systems in satellites. The flywheel in this prototype, visible through the openings, is about 10 inches in diameter and weighs about 12 pounds. Two such flywheels would be used in a typical small satellite.

PHOTO: DRAPER LABORATORY

Regulating Radiowaves: A Patchwork Approach

Industries rarely head to Washington in search of safety and environmental regulations. However, a coalition of some of the country's most important electrical engineering and telecommunications firms is doing just that. The Electromagnetic Energy Policy Alliance (EEPA), representing companies such as Motorola, AT&T, RCA, Rockwell, and Raytheon, and groups such as the National Association of Broadcasters, was formed last year to lobby for a national standard regulating exposure to radio waves and microwaves. EEPA's goal is not to obtain stiffer protection for the citizenry. Rather, the group wants to head off proliferating state and local regulations that it fears may hobble the use of technologies generating electromagnetic radiation (EMR).

Radio and television broadcasting generates waves in frequencies between about 100 kilohertz and 300 megahertz. Microwaves, from microwave ovens, radars, and microwave communications, have frequencies higher than 300 but less than 300,000 megahertz—the frequency that marks the beginning of the infrared band.

Microwaves and radio waves can heat humans just as infrared or visible light does. But while light heats the skin, radio waves and microwaves penetrate body tissue, where they produce heat by making water molecules vibrate. Microwaves from powerful radar radiation have been linked—though not definitively—to headaches, cataracts, internal bleeding, and even leukemia and brain tumors. In the 1960s, the military adopted a limit of 10 milliwatts per square centimeter to protect employees from these effects.

Human Antennae

All current regulations limit whole-body exposure to no more than the ceiling set by the military. The American National Standards Institute (ANSI) has adopted this standard as a voluntary guideline for industry. However, there is a growing concern that this level of protection may not be adequate. (Anyone who stands close to a walkie-talkie antenna can absorb more than this limit.)

So far, only Massachusetts and New Jersey have adopted EMR regulations that protect the general population. The Massachusetts standard, adopted in 1983, sets exposure limits at one-fifth the recommended ANSI level. The only concrete impact on industry—other than increasing reporting requirements—was the minor rerouting of some microwave transmission lines-of-sight, says Robert Watkins, a scientist with the Massachusetts Department of Public Health.

Some 13 other state legislatures are actively considering EMR regulations, and EEPA is concerned that state and local officials may take stands it considers unacceptable. Officials in Kitsap County, outside Seattle, have already done so. They refused RCA permission to build a ground station for satellite communications because RCA couldn't prove that the facility would be safe. Yet radiation levels from the facility would have been far below ANSI's ceiling.

Chronic Exposure

The pressure for strict local measures stems from the fear that the ANSI ceiling may not protect people from chronic exposure at lower levels. Researchers have found that low-level exposures seem to promote the movement of calcium across the blood-brain barrier—a phenomenon called "calcium efflux" that may apply to other substances as well. However, nobody knows whether this increased flow is hazardous.

Scientists do know that certain parts of the body—hot spots—absorb EMR more efficiently than others, and that may cause problems. "Say you had a warm spot in the hypothalamus of the brain, which controls body temperature," says Arthur W. Guy, director of the Bioelectronics Research Laboratory at the University of Washington. "That may fool the body into making all kinds of physiological responses; nobody really knows what the side effects of those responses are."

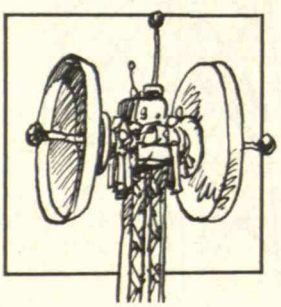
This nagging uncertainty is the major stumbling block in the quest for a uniform federal regulation. EEPA officials say they might be willing to support a federal standard at or near the lower ceiling of 1 milliwatt per square centimeter that ANSI recommended in 1982 for frequencies between 30 and 300 megahertz. (It turns out that people make better an-

ILLUSTRATION: JON MCINTOSH

tennae for EMR at those frequencies than at higher and lower frequencies.) However, industry officials are concerned that some states may adopt exposure limits much lower than the 1982 ANSI guidelines.

"People say, well, if that's the regulation now, we ought to make ours ten times more restrictive so there's no chance of any problem," says Richard Ekfelt, EEPA's executive director. "Pretty soon, as state follows state, you've got regulations that are hundreds of times more restrictive than need be." Such regulations could cost the industry millions of dollars by requiring it to realign broadcast towers and microwave dishes, or to relocate broadcast parks.

"We would prefer a federal standard that is reasonable and not overly restrictive," Ekfelt says. While states have the right to adopt more stringent regulations, most end up adhering to whatever federal standard exists. However, officials at the Environmental Protection Agency are not convinced that a mandatory ceiling as strict as the ANSI guideline is necessary. As a result, they have decided to solicit comments from industry, the scientific community, and the public on a range of exposure ceilings—including no ceiling at all. It could be years before a final standard is enacted. —*David Kennedy* □



They Don't Cut Ribbons in Subway Tunnels

The pyramids of Egypt remain standing after almost 3,000 years of natural and human abuse. The Great Wall still winds 1,500 miles through the vast Chinese heartland, and the 2,400-year-old Parthenon continues to grace an Athenian hilltop. Yet what many consider the greatest public-works achievement in the United States has deteriorated to an almost irreparable condition after less than 80 years. Neglect has done more harm to the New York subway system than thousands of years of natural erosion did to the Sphinx.

To Robert Kiley, chairman of New York State's Metropolitan Transit Authority (MTA), the condition of New York City's public-transit system is an expression of something terribly wrong with the way we build, fund, and maintain public works in this country. "It is a story of magnificent starts and staggering indifference to what exists," says Kiley. "We Americans build superb highways, bridges, dams, and buildings. But we seem incapable of properly caring for them afterward."

When government finally decides to begin restoring this infrastructure, it must invest enormous funds. Two years ago New York State agreed to allocate $8.5 billion over five years to upgrade the New York City transit system. This includes 700 miles of subway track as well as two commuter rail services, the Long Island Rail Road, and the Metro-North Rail.

Yet even that huge sum will not be enough to keep the system alive, according to both Kiley and Boris Puschkarez, vice-president of research for the Regional Plan Association, a nonprofit organization that has studied transit since 1928. The state or city must also build into the MTA's operating budget a capital-depreciation account for replacing equipment, track, and buildings, says Puschkarez. "Any self-respecting company sets aside this kind of fund. Yet no public-transit system in the United States has." That includes even the new Metro in Washington, D.C., and the Bay Area Rapid Transit (BART) system in San Franscisco.

"For the time being, they have good equipment," says Puschkarez. "But after a while, who knows?" Local funding will have to play an increasing role in the upkeep of such systems as the federal government's traditionally strong financial support of mass transit continues to erode.

Deeper Political Problems

Lack of money for maintenance is not the only obstacle to the survival of America's public works. Kiley believes it is merely a symptom of an urban political system that prefers the payoff of more visible projects and is skewed by the money of special-interest groups.

"Politicians get little mileage out of putting in new signals, modernizing equipment to wash subway cars, or replacing worn track," Kiley explained last November at M.I.T. "Ribbon cuttings are not held in the middle of subway tunnels."

Kiley points to the construction of the $800 million 63rd Street tunnel from Manhattan to Long Island City in Queens as one costly result of politicians' penchant for ribbon cuttings. The tunnel was designed to bring service to outer Queens, but the subway line the tunnel was to connect with was never built. When it opens next year, this subway tunnel will carry only 220 passengers per hour under the East River, even at peak times. "That's an expensive mistake even by New York standards," says Kiley. And while this "mistake" was being built, only about $138 million each year went into maintaining the existing subway lines. Kiley estimates that $500 million would have been the bare minimum needed annually to prevent their deterioration.

Managing for Maintenance

Now that funding for upgrading the New York system is in place, at least for the time being, Kiley has turned his attention to the second problem: the influence of special-interest groups—the unions, in this case—on elected officials. He spent his first year at the MTA trying to wrest control of subway supervisors from the unions.

"The federal Wagner Act prevents supervisors in private industry from belonging to unions," Kiley says. However, until recently, all 5,500 line supervisors working in the New York subway were union members and largely exempt from managerial control. "Only a few hundred of the MTA's 49,000 workers

could be promoted, demoted, or dismissed by the agency's president," Kiley notes. Aggressive unions secured such protection in the 1960s and 1970s partly by contributing generously to politicians' campaigns.

"It was the system we needed to make progress against the kind of Boss Tweed cronyism that used to exist in New York," says John Law, spokesman for Local 100 of the Transport Workers Union. "And I think it is the fairest system we've had so far."

However, after 10 months of lobbying, the MTA management won permission from the New York State Civil Service Commission to remove 1,200 line supervisors from the union. The MTA also negotiated an agreement to give management greater flexibility in assigning jobs to maintenance workers.

Removing the remaining 4,300 supervisors from the union and putting them under management control may be the "toughest battle of them all," says Kiley. Elected officials could fight reform, fearing that unions will withdraw financial support from upcoming campaigns. So far, New York City Mayor Ed Koch and New York State Governor Mario Cuomo have supported these reforms.

Unfortunately, Law says that Kiley's efforts have created a confrontational atmosphere between management and the unions that could make operating the subway even more difficult than before. Yet the MTA chairman believes the transport workers should continue to have the protection of a union. His concern is gaining managerial control over supervisors, and he could be making headway in that area. John Michaels, spokesman for the Subway and Surface Supervisors Association, the union the MTA is actually negotiating with, says that "there's a possibility the war may end." He and Kiley may be close to an agreement, but he cannot disclose the details.

In the meantime, the jury is still out on the fate of New York's subway system—and, for that matter, of this country's entire infrastructure of bridges, highways, and mass-transportation systems.

—*Alison B. Bass* □

The New York City subway system, which carries 3.3 million passengers per day, has fallen into an almost irreversible state of disrepair. For decades, city and state officials have neglected funding for its upkeep, preferring the political payoff of more visible projects.

PHOTO: DANNY LYON, MAGNUM

The German Reactor Advantage

Nuclear reactors in West Germany have performed significantly better than reactors using essentially the same technology in the United States.

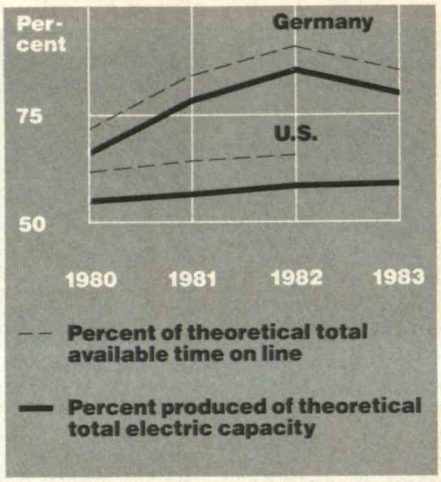
Three reasons: U.S. utilities operate in a less satisfactory economic environment than their West German counterparts; U.S. utilities, pressed by investors seeking high dividends and consumers seeking low prices, try too hard to economize; and under political pressure, U.S. regulation lacks the stability that has characterized Germany's management of its nuclear industry.

These are the preliminary conclusions of Professors Kent F. Hansen of M.I.T. and Dietmar K. Winje of the Technical University of Berlin in a study for M.I.T.'s Center for Energy Policy Research.

The difference in performance between German and U.S. reactors is striking and consistent. In 1981, for example, the six German reactors studied by Professors Hansen and Winje produced just under 80 percent of the total power they could theoretically have produced. For 21 similar reactors in the U.S., the comparable figure was 58.6 percent. The German reactors were on line 82.5 percent of the possible time after allowing for necessary maintenance and refueling, while the U.S. machines were on line 68 percent of the possible time.

The economic situation of U.S. utilities is less favorable than that of German utilities. Interest rates are lower in West Germany than in the United States, and so are the taxes on utilities. The pressure to pay stockholders high rates of return is also less in Germany. This is partly because German state and local governments are major utility stockholders, and it is in their interest to establish efficient plants.

Perhaps pressed by the high cost of coal in Europe, West German utilities have been more efficient nuclear managers than U.S. utilities, say Hansen and Winje. One example of the result: refueling a German reactor takes less time than refueling a U.S. reactor because of the Germans' more careful planning. American utilities that took the nuclear option have experienced heavy economic pressure that may have affected the overall quality of U.S. design, workmanship, and operation, say Hansen and Winje. In particular, the pressure for economy seems to have affected one design decision in a way that has been costly for U.S. operators: they have elected to build smaller reactor containments than those used in Germany. The result is that there simply isn't enough space around many U.S. reactors to do maintenance and repair quickly and efficiently. Hansen and Winje conclude that "U.S. outages could be shortened with easier access to equipment."



West Germany's nuclear industry has a better performance record that that of the U.S. The reason, say two nuclear experts in an M.I.T. energy policy report, is that economic and regulatory pressure in the U.S. has been heavier than in Germany.

Like U.S. utilities, German producers are regulated by state commissions that must approve prices charged to consumers. But the German regulators take into account the costs of construction work in progress in their rate decisions, while this has been a source of great controversy in the United States.

Nuclear licensing and regulation are similar overall, and there is an opposition movement to nuclear power in Germany as there is in the United States. But the American movement has used its access to the courts to gain more political and legal clout, with the result that the German regulatory process is "relatively stable" compared with that here, say Hansen and Winje. German regulators have required fewer changes in operating reactors and have permitted more of them to be done during scheduled refueling and maintenance. Indeed, say Hansen and Winje, the impact of regulation appears to account for "the single largest difference" between U.S. and German reactor results. □

Words vs. Productivity

If you want to know the productivity of a manufacturing plant, don't call the plant manager; ask the director of labor relations two questions:

□ How many words are there in your labor contract?

□ What is the grievance rate at your plant?

The longer the labor contract and the higher the grievance rate, the lower the productivity, writes Casey Ichniowski of Columbia University Business School.

Ichniowski's conclusion emerges from his just-published thesis research in the M.I.T. Sloan School of Management. He studied productivity differences among eleven paper mills—ten unionized and one non-union. Productivity was lowest in the non-union mill. In the ten unionized mills, productivity varied inversely with the number of pages in the union contract—high for mills with short contracts, lower for mills with longer contracts. Ichniowski found a similar inverse correlation betwen grievance rates and productivity.

Ichniowski admits that his M.I.T. work is incomplete, in the sense that "the mechanism by which morale and labor relations affect a plant's efficiency is left unclear." But the correlations are "significant," he writes: "A grievance-free firm is 1.3 percent more productive and up to 16.7 percent more profitable than a firm . . . with an average grievance rate." □

Making a Market in Electricity

Can the laws of supply and demand that govern conventional markets—high prices for scarce goods, low prices for plentiful ones—help motivate Americans to conserve electric power in their homes and industries?

A proposal to use microprocessor technology to establish "homeostatic control"

of electricity prices is now under study at M.I.T. The idea is to set electricity prices according to supply and demand, with customers able to learn the price before they decide to turn on the switch. Use the reading light when you need it, of course; but don't wash the dishes or dry the laundry until the price comes down, later in the evening.

"Homeostatic control"—the name comes from a biological term for a state of equilibrium between different but interdependent elements of an organism—would let customers help utilities trim peak loads. One recent study showed that if these principles were embraced by the government-owned power system in Britain, annual operating and capital costs could be reduced by as much as 15 percent. Customers could help a coal-burning utility in the U.S. save as much as $4.7 million a year in operating costs, according to a computer simulation.

Here are the basic ideas behind homeostatic control, as envisioned by Professors Fred C. Schweppe and James L. Kirtley, Jr., of the Department of Electrical Engineering and Richard D. Tabors of the M.I.T. Laboratory for Electromagnetic and Electronic Systems:

☐ The local utility's market coordinator would compute once an hour—or perhaps more often—the price of electricity and send that information to customers. The customers could then decide for themselves about when to use and when to save.

☐ Utilities would give customers two kinds of service: some essential power would be guaranteed, and some power (at a lower price) would be interruptible during emergencies or times of high load.

☐ There would be special charges for customers whose response in a time of stress—a frequency drop, for example—was a hindrance rather than a help to the system, or for customers whose equipment contributed to power-system oscillations or other problems.

Such variable rates would have been unthinkable a decade ago—and still are to many utilities, say the M.I.T. engineers. But the declining costs of computers and communications are leading some utilities to test some of these basic concepts. And a new "energy crisis" might bring homeostatic control into its own. ☐

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